POWER PLANT ENGINEERING

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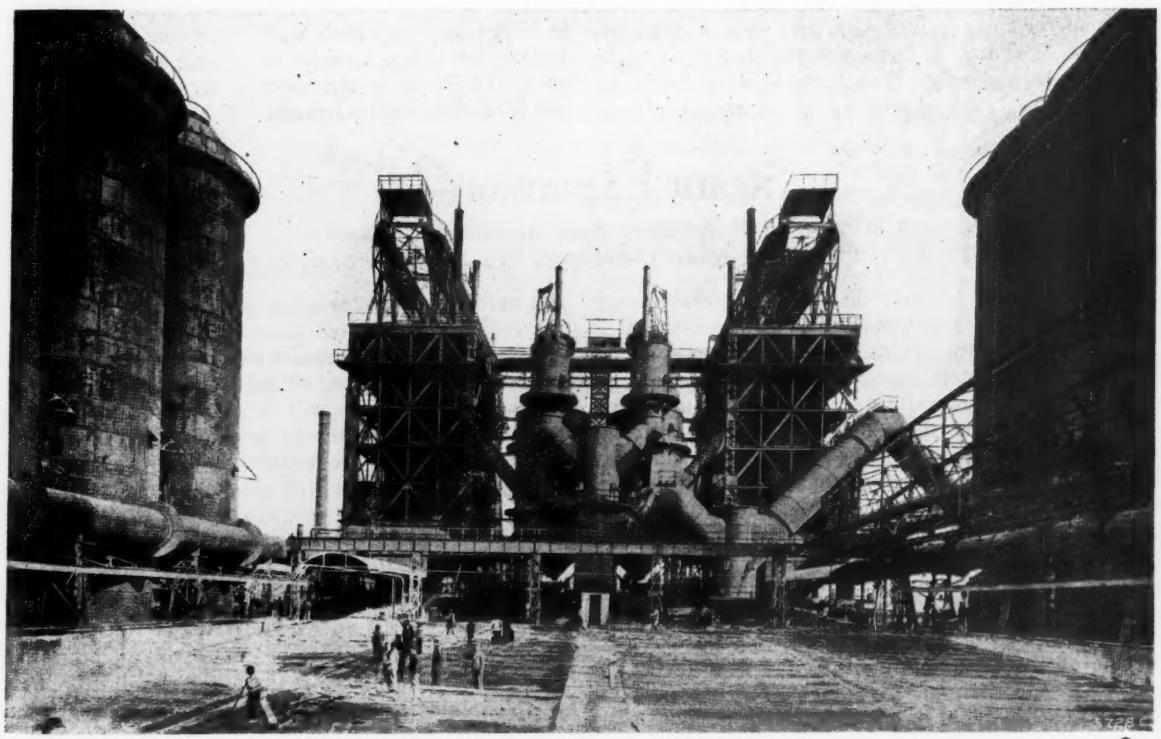
A French Blast Furnace Plant

GAS-ENGINE AND STEAM-TURBINE-OPERATED ELECTRIC GENERATING AND BLOWING SETS EMPLOYED AT MONDEVILLE-COLOMBELLES IRON AND STEEL WORKS

EMBODIED IN A detailed description of The Mondeville-Colombelles Iron and Steel Works of The Societe Normande De Metallurgie, Caen, France, appearing in a recent issue of Engineering of London, is an account of the power plant there installed for the generation of electrical energy and the operation of the blowing engines.



BLAST FURNACE PLANT OF THE MONDEVILLE-COLOMBELLES IRON AND STEEL WORKS

The blast furnaces, which are of the 400-ton type, are shown in the accompanying illustration. They are fitted with sixteen 5⅞-in. tuyeres and eight bosh tuyeres, the blast being heated in five Cowper stoves, each of which has a height of 108 ft. 3 in. and a diameter of 23 ft. Under normal working conditions, the pressure of the blast is 11.6 lb. per square inch.

All operations for charging the blast furnaces are carried out mechanically. Ironstone, which is transported in 50-ton self-discharging wagons, is delivered in underground silos having a capacity of from 1800 to 2000 tons, and provided at their lower part with electrically-operated trap-doors which allow the delivery of the required quantity of each class of ore and flux into a circular skip, 9 ft. 10 in. in diameter, having a movable conical bottom, carried on an automatic weigh-bridge mounted upon an electric tractor. When the skip is filled it is placed on the lift by a traveling crane. Similar skips, each of 5 tons capacity, are filled with

coke at the coke ovens; they are brought to the lift by means of an electric tractor. The lift is on the Munier system, contained in a vertical tower connected to the flooring round the throat by a bridge on which runs a traveling crane.

The ore skip is raised to the upper level from the lower part of the silos by a winch. On the upper level, the vertical motion is transformed automatically into a horizontal traversing motion; the skip is then hoisted and it finally stops automatically above the throat opening. It is then lowered, and fits the bell, whilst a gas-tight cover closes the upper part of the skip; the bottom part of the skip is lowered with the bell, and the charge falls in the blast furnace. The same operations are then repeated in inverse order, when the empty skip returns to the lower part of the silos, or, in the case of the coke skips, to the coke-skip truck.

The winches operating the hauling and traversing of the skips, the electric motors, transformers and other machinery required for two blast furnaces, are contained in one electric substation.

Power Station

The prime movers in the power station are gas engines and steam turbines, the latter normally destined to act as standby to the former, but they were set running on starting the plant, and so far have contributed to the supply both of power and of blast to the furnaces. There are at present two generating sets driven by Rateau turbines, each of 4500 hp., while a third set, to develop 7000 hp., is being completed, and is to be started working shortly. Two turbo-blowers driven by Rateau turbines, each of 3000 hp. minimum, supply the blast to the furnaces. One of these is a steel works machine, capable of delivering blast at a pressure of 35.5 lb. per square inch, while the other is a blast furnace machine delivering the blast at a pressure of 14.2 lb. per square inch. A third turbo-blower of from 200 to 300 hp. serves to maintain the pressure in the air pipes. Apart from the above steam-generating sets, the plant contains two gas-engine driven generating sets of 6000 hp. each, supplied by the Societe Alsacienne de Constructions Mecaniques, Belfort; one is to start working shortly, and the second in the course of a few weeks. It contains, further, two blowers driven by blast-furnace gas engines, built by Messrs. Schneider and Co., each of about 3000 hp., to supply blast to the blast furnaces; one of these units has run since May 5, 1918, and the second will be started shortly. A gas-driven blowing engine set of 6000 hp. supplies the blast to the basic converters in the steel works. The power thus available amounts to a total of 54,000 hp.

Consumption of electric energy in the whole plant amounts to about 20,000 hp. To supply this, three of the alternators will suffice, two gas-driven and one steam-driven, or vice versa, the other units remaining as standby. There is, therefore, a large reserve power to meet all possible emergencies, and the extension of the auxiliary services.

In regard to blast, in normal times there will be working, for the blast furnaces, the gas-engine driven blowing sets, the steam turbine-driven set acting as a standby; for the steel works, the gas-engine driven blower, the steam turbine-driven unit being held in reserve. This latter can also, on an emergency, supply the blast-furnace department.

Steam Expansion---II

Actual Engine Efficiency; Ratio of Expansion; Significance of Clearance. By Roger Taylor

IT SHOULD now be clear that the net useful energy obtained is quite small compared to the amount it is necessary to supply to the engine, by the study of the theoretical perfect engine in which there are no wastes or losses, and while it is possible within certain limits to increase the theoretical efficiency by a change of the temperature and pressure range, it is principally with the reduction of the amount of the wastes and losses, which represent the amount by which the actual engine falls short of the theoretical engine, that the engineer is most concerned. The losses result from incomplete expansion, clearance volume, friction, radiation, cylinder condensation, leakage of valves and piston, wiredrawing, etc.

One of the most important factors is probably the one relating to the number of expansions used and the relation that the point of cutoff and back pressure bears to the number of expansions.

By the number of expansions is meant the number of times the steam enclosed in cylinder at point of cutoff is increased in volume when at a point in the cylinder known as release. Steam being a very elastic substance and having the property of completely filling any space or volume in which it may be enclosed, results in a change of pressure for any change of volume; that is, if a unit weight of steam, present as steam, in any given space, should be allowed to expand and occupy a larger space, such as would result from the movement of the piston of an engine, after cutoff of steam supply, the pressure of the steam will fall. Stated as a law, it is said that "the pressure of a gas at constant temperature varies inversely to the volume" and is written $PV =$ constant. A curve plotted from this equation showing the relation between pressure and volume in the engine cylinder gives a diagram such as Fig. 6 in which b. c. is the expansion line and is termed the hyperbolic curve.

In Fig. 7 let steam of 120 lb. absolute pressure be admitted to the cylinder and carried at full pressure to point of cutoff from a to b. After this point, without any further steam supply, the pressure will drop, owing to the volume being increased by the movement of the piston, and the pressure will be inversely proportional to the volume at any other point. Let the stroke or distance dc be 36 in. and the cutoff take place at ¼ stroke or 9 in. Then $36 \div 9 = 4$ equals the number of expansions. If the volume of cylinder at point of cutoff "b" be taken as unity 1, then the total volume of cylinder will be four of such volumes and the number of expansions will again be found to be equal to 4. Also

if the terminal pressure is known to be 30 lb., then $120 \div 30$ will give four expansions.

To find the pressure at any point of the stroke after cutoff and so construct this hyperbolic curve by using the equation PV = constant, let the volume up to the point of cutoff be taken as unity, then PV = constant = $120 \times 1 = 120$, and the pressures on the vertical lines 2, 3, 4 will then be 120/2, 120/3, 120/4, equal to 60, 40, 30 lb. absolute respectively, and a line drawn through these points will show the fall in pressure due to the increase in volume. By taking the travel in inches of the piston the same results will be obtained, as with cutoff at 9 in., then PV = constant = $120 \times 9 = 1080$ and the pressures at 18, 27 and 36 in. of travel corresponding to points 2, 3, 4 will be 1080/18, 1080/27, 1080/36 equal to 60, 40 and 30 lb. absolute as found before. With an earlier point of cutoff, the number of expansions will be increased, as shown by Fig. 7, where cutoff takes place at point b_1 at ⅛ stroke, the expansion line will be as shown on b_1c_1. The number of expansions will be 8, and the terminal pressure $120 \div 8 = 15$ lb. absolute. The expansions found so far are what are termed the apparent number of expansions, no attention having been paid to the modifying effect of the clearance of the cylinder upon the number of expansions.

Effects of Clearance

This clearance must be filled with steam at each stroke of the engine, either partly or wholly, with a

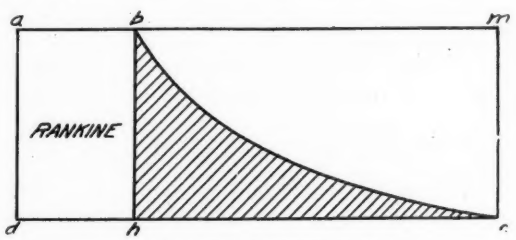


FIG. 6. THE RANKIN CYCLE

fresh supply, or by the amount remaining in the cylinder to form the compression, by the early closure of the exhaust valve.

It will now be seen what the effect of this clearance steam has upon the number of expansions, compared with the apparent number as found above. In Fig. 8 let the rectangle "mado" at the left of the figure correspond to a clearance volume of 4 per cent which is 4 per cent of the piston displacement, then "od" equals $36 \times 0.4 = 1.44$ in., which must be added to each of the values of piston travel at points 1, 2, 3, 4 in order to obtain the true number of expansions, as $9 + 1.44 = 10.44$ in., which is the true volume at cutoff that is filled with steam and $36 + 1.44 = 37.44$ in. is the volume at end of stroke. Then $\frac{37.44}{10.44} = 3.58$ expansions actually, as against the apparent four expansions found above where the clearance was neglected. The volumes at points 1, 2, 3, 4 are then found to be by adding the clearance length of 1.44 in. to the piston travel at the several points, 10.44 in., 19.44 in., 28.44 in. and 37.44 in., and the pressures will be from the equation PV = constant $= 120 \times 10.44 = 1252.8$ and at verticals 2, 3, 4 found to be 64.4 lb., 44 lb. and 33.4 lb. absolute, respectively, and when plotted to form the expansion curve bp, Fig. 8, have the effect of bringing this expansion curve higher than in the case where the clearance was not considered.

As the result of the clearance steam then for a given point of cutoff, the expansion curve is higher, the area of the expansion part of the diagram is increased and the terminal pressure is higher, so that for a fixed terminal pressure the number of expansion is increased above the number where clearance is not considered. By the early closing of the exhaust valve and compression

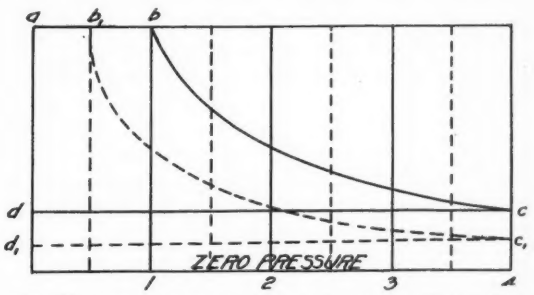


FIG. 7. DIAGRAM TO SHOW NUMBER OF EXPANSIONS

of the steam enclosed to the admission pressure, it is possible that the loss due to the clearance volume may be removed, provided the expansion after cutoff is carried to the back pressure. If the expansion line bp, Fig. 8, should fall to back pressure line dc and compression start at some point h, compression steam to initial pressure a, then area dah and area cbp would be equal and there would be no loss by clearance steam.

After the point of cutoff at b, Fig. 6, the area bch will represent the gain in work area, by taking advantage of the elastic force of the steam by using its internal heat energy, and the extent to which the expansion is carried will have great bearing upon the closeness of the actual engine efficiency to the ideal engine efficiency.

Measurement of Work Done

In considering the relative gain in work area on the card by the use of steam expansively, it must be remembered that length on the diagram represents distance

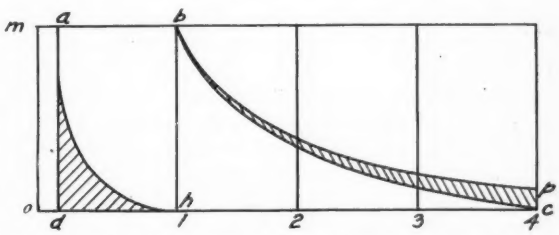


FIG. 8. DIAGRAM SHOWING EFFECT OF CLEARANCE VOLUME

and is proportional to the travel of the piston within the cylinder, that the vertical height is proportional to the pressure of the steam, and that when pressure or force is exerted through space as shown by the length on the diagram, the result is work done, so that the product of the height and length, or the area of the diagram is a measure of the work done per stroke of the engine.

In the rectangular diagram enclosed by amcd, Fig 6, if steam is admitted for full length of stroke dc at a

pressure proportional to da, the mean pressure would be that due to the initial pressure da. If, however, the steam supply be cut off at any point as at b, the mean pressure would be lower than in the previous case, owing to the fall in pressure during the expansion period and since the area enclosed by the diagram is less than the area enclosed by the rectangular figure, the work area is lower. If steam of 120 lb. absolute be admitted to a cylinder full stroke as in the rectangle amed, Fig. 6, and the volume of that space be 4 cu. ft., the actual weight of water in the form of steam needed to fill this volume will be 1.07 lb., since, from the steam tables, 1 lb. of steam at 120 lb. absolute pressure has a volume of 3.73 cu. ft. and the amount of work done for this weight of steam will be represented by the area of the rectangular diagram.

If, however, the steam supply is cut off at ¼ of the stroke, then the volume up to this point will be 1 cu. ft. As all the steam that will be supplied to the cylinder for the stroke of 4 cu. ft. volume is now present in this volume of 1 cu. ft., the actual weight of steam present will be $\frac{1}{3.73} = 0.26$ lb. As further work is obtained from this weight of steam after cutoff during the expansion period. The total work area done by this 0.26 lb. of steam is represented by area abcd.

It will be readily seen that while the amount of actual water as steam it has been necessary to use in this case is only ¼ of the amount used in the previous case, the work area is considerably more than ¼ of

TABLE III. RATIO OF POWER DURING EXPANSION TO THAT UP TO CUTOFF

Point of Cut off	Ratio of Expansions	Hyperbolic Log. Ratio of Expansions
1/4 stroke	8	2.0794
1/5 "	5	1.6094
1/4 "	4	1.3863
1/3 "	3	1.0986
1/2 "	2	0.6931
3/4 "	1.33	0.2624

the area in the rectangular diagram; in fact, it exceeds that amount by an amount of area equal to bch. It should be clear that by the use of steam expansively, the amount of work from a unit weight of steam is considerably greater than when used non-expansively.

Use of Hyperbolic Logarithms

For any given point of cutoff and therefore any given ratio of expansion, the area enclosed by the diagram during the expansion period, bears a definite relation to the area up to the point of cutoff, provided, as is commonly assumed, that the expansion is hyperbolic, and the values of this relation are given in the tables of the hyperbolic logarithms. If the area of the diagram up to the point of cutoff is taken as unity 1, the value of the hyp. log. of the number of expansions, gives the number of times the area of the diagram during the expansion period, contains the area up to the point of cutoff. In Fig. 6, with cutoff at ¼ stroke neglecting clearance, the ratio of expansion will be 4, the hyp. log. is given by the tables as 1.3863, therefore the area of the diagram after cutoff is 1.3863 times the area up to that point, which represents the gain in work area by the expansive working of the steam. Had the steam been carried at full pressure throughout the full length of the cylinder, the work area would have contained four of the unit areas abhd and would have required, as stated before, 1.07 lb. of steam at 120 lb. pressure, or 0.26 lb., would be used for each unit area "abhd." But with expansive working of the steam, the total work area would contain $1 + 1.3863 = 2.3863$ of such unit areas

TABLE IV. PRESSURES AND EXPANSIONS

Initial pressure P absolute	Final pressure p	Pressure difference P - p	Expansions
150	15	135	10
150	10	140	15
150	5	145	30
150	2	148	75
150	1	149	150
150	0.5	149.5	300

with 0.26 lb. of steam supplied to the one unit up to the point of cutoff. The same 0.26 lb. of steam performing additional work equal to area bch, so that the weight of steam per unit area abhd would be $\frac{0.26}{2.3863}$ equal to 0.108 lb., approximately 41 per cent of the amount where used non-expansively, which shows clearly the reduction in steam consumption. Reference to Table III will show the effect of the early cutoff upon the relative areas of the diagram before and after cutoff.

Practical Limit to Number of Expansions

Reference has been made before to the fact that there is a limit to the extent to which the expansions may be carried in the reciprocating engine, particularly in the single cylinder engine, in which the losses due to cylinder condensation may attain considerable magnitude. Where the attempt is made to carry a large number of expansions within a single cylinder, the result is a large temperature range in the cylinder at each stroke of the piston. The incoming steam at admission striking the relatively cold surface of the cylinder walls, following the exhaust of the steam at the lower temperature rapidly condenses. The amount of condensation may be quite large at this point, but owing to the partial re-evaporation which occurs later, the loss from the initial condensation may be somewhat reduced, although it is usually quite large. This re-evaporation results from the drop in pressure within the cylinder during the expansion period, the temperature corresponding to the pressure, becoming lower than the temperature of the previously formed moisture, which is then partially re-evaporated into steam. This is repeated throughout ex-

pansion and has the effect of lowering the pressure at the beginning and raising the pressure at the end of expansion, modifying somewhat the form of the curve.

During exhaust, owing to the drop in pressure, considerable of the moisture is re-evaporated into steam, passing off into the exhaust. The range of temperature then has a limiting effect upon the number of expansions used, owing to the condensation which must necessarily accompany large temperature changes. The temperature curve in Fig. 1 shows how the temperature falls rapidly at the lower pressures and also the curve of volumes shows the very large increase in volume of 1 lb. of steam at the lower pressures. This curve is plotted from the saturated steam tables and while the expansion curve of the actual engine does not follow these values, unless some means are provided such as steam jacketed cylinders, to maintain the steam during expansion in a condition corresponding to the condition as to pressure, temperature and volume of the steam tables. The equation of the saturation curve is approximately $PV^{1.7} = \text{constant}$, whilst the usual curve during expansion is commonly assumed to follow the hyperbolic curve, where $PV = \text{constant}$. There are, however, several factors which may influence the character of the expansion line of the diagram, and which may cause it to deviate more or less from the hyperbolic curve, as the condensation caused both by the passage of heat to the cylinder walls, and the loss of heat from the steam by work done, re-evaporation of the moisture caused by the above loss of heat, condition of the steam up to and at the point of cutoff. In general, however, it can be assumed that the expansion curve of the engine card is fairly satisfactory, if by super-imposing the hyperbolic curve upon the card, the two curves nearly coincide.

In order to take advantage to the fullest extent of the benefits resulting from the expansive working of the steam and at the same time reduce to a minimum the losses from cylinder condensation, it is the usual practice to so divide the work as to be done in two or more cylinders, increasing in size to accommodate the increased volume of the steam. The temperature range within any one cylinder is then reduced with a corresponding reduction in the losses. The cylinder may be so proportioned as to divide the work equally. Inasmuch as there are difficulties in the construction of cylinders of the extremely large volume which would be necessary if expansion were carried down to the very low pressures, consequently the expansions are limited in the reciprocating engine. These difficulties do not enter into the case with the steam turbine, in which the lower pressure limit should be carried as far as possible. Table IV brings out the point that if economy is the result of an increased expansion, large increase in economy is to be expected where the final pressure is brought down to 0.5 lb. absolute. It would, of course, be manifestly impossible to reach these values in the reciprocating engine, although they are quite common in present day turbine plants.

Improving Factory Power Plants---VII

CASE IV. CONCLUDED. PLANT ROUTINE AND RECORDS. BY H. A. WILCOX

AS A result of the changes outlined in the previous article, page 184, February 15 issue, and the efforts of the fireman, we were able to carry the entire plant on one boiler when the load was light. During the summer months we ran only two boilers for some time and could have continued to do so, if the Government had not suddenly cut off our supply of No. 1 buckwheat and compelled us to use rice instead. This rice, at times, was practically culm and to produce the necessary amount of steam, under present labor conditions, we had to resort to three boilers and the occasional use of the steam blowers. I have always disliked forced draft, produced by steam jet blowers, as I know that they are not economical and generally require from 5 to 10 per cent of the total steam generated by the boilers for their operation, the later figure being by far the most common.

I am unable to make any definite statement as to the savings accomplished through the various changes which were made, for I have no figures of previous operation that are reliable enough for purposes of comparison. I do know, however, that when about half the changes had been made I found that the plant was using about 55 wheelbarrows of coal a day. We were weighing each wheelbarrow and this corresponded to a use of about 7½ short tons a day. An inspection of the records of previous years showed a use of about 10½ short tons a day. This apparent saving was made in spite of the fact that we had increased the load on the engine by about ⅓ over what it had carried in previous years.

In winding up my work at this plant, I installed a series of ticklers, a daily log system, and a schedule for "Maintenance and Operation" of the power department. A blank sample of a log and a tickler are shown below and the logs showed that we were getting an actual evaporation of between 7 and 8 lb. A copy of the schedule is also shown in full.

Just a word about the operation of ticklers. I have filled in the sample shown and the form shows what is wanted. Please note that the man who receives the tickler signs it after he has completed the work called for and that it goes to the manager who in turn initials it. This then constitutes a running signed record of this particular job and in case of trouble shows at once who is responsible for the job. All ticklers are kept in a drawer containing the calendar in the form of cards. Each tickler is inserted in front of the card bearing the date at which it is desired to have the tickler come out. A clerk in the office is assigned to take care of the ticklers. He looks in the drawer the first thing each morning and takes out all the ticklers for that particular date and distributes them to the proper parties, making a record in a book provided for the purpose of the number of the tickler and to whom issued and the date of issue. The work is carried out promptly and the signed tickler placed on the manager's desk, who in turn initials it and returns it to the clerk. The clerk checks it off on his book and inserts it in the drawer under the next date when it is due to come out. If the party to whom the tickler is issued does not have time to complete the work, he marks it not completed and returns it just the same. If the tickler is not returned in five days after the date of issue the clerk knows it, as he

refers to his book every morning, and he gets after the person to whom it was issued. If after three days more the tickler does not come back, the clerk makes a written report to the manager, who should and does dig into the matter.

Each tickler, when made out, has to bear the approval of the manager and is issued in duplicate and the duplicate copy is given the same number as the original and is pasted in a book kept by the tickler clerk. Thus in case a tickler gets lost, it is an easy matter to issue a duplicate. I consider this tickler system to be one of the most valuable things for use in any work, as the whole thing depends only upon the manager to see that it is properly carried out and he is automatically notified in case of trouble. I use a tickler in my personal affairs and find it a very valuable adjunct. The system is very elastic and adapts itself to almost any kind of work.

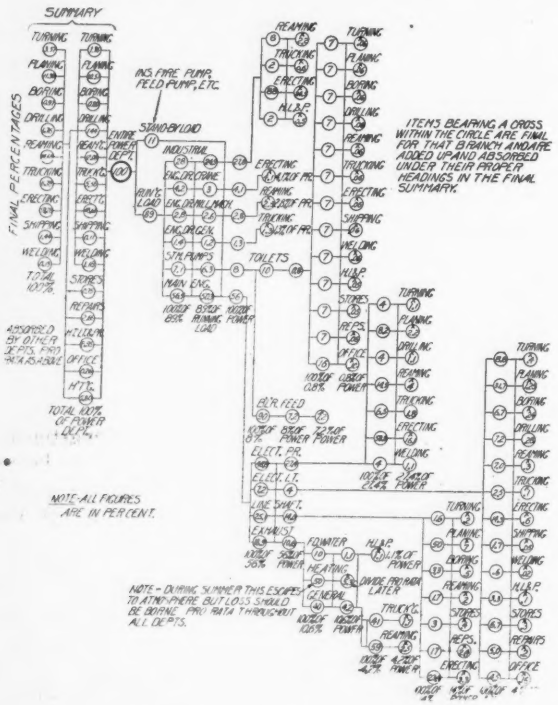

SUMMARY
FINAL PERCENTAGES
INS. FIRE PUMP. FEED PUMP, ETC.
STAND-BY LOAD
ITEMS BEARING A CROSS WITHIN THE CIRCLE ARE FINAL FOR THAT BRANCH AND ARE ADDED UP AND ABSORBED UNDER THEIR PROPER HEADINGS IN THE FINAL SUMMARY.
NOTE - ALL FIGURES ARE IN PER CENT.
NOTE - DURING SUMMER THIS ESCAPES TO ATMOSPHERE BUT LOSS SHOULD BE BORNE PRO RATA THROUGHOUT ALL DEPTS.

FIG. 2. CHART SHOWING DISTRIBUTION OF POWER COSTS

My final piece of work at this plant was to get up a chart for distributing the cost of the power department throughout the various departments of the mill and scaling these percentages down so that in the end the entire cost of operation of the department was absorbed in eight divisions. This chart is reproduced in Fig. 2. The entire cost of running the power department, including depreciation, interest on investment, repairs, etc., was called 100 per cent. As the distribution was in percentages, it made no difference whether the cost was high in the summer and low in the winter or vice versa, for the percentages did not change. The distribution was obtained from previous knowledge of the requirements of the various machines for steam, power, etc.; from former records, and other data. For obvious reasons and at the request of the management of the plant, I have replaced the real names of the departments with those of the machines and work in a machine shop. This makes no difference, however, as it is the method used rather than the results obtained which I wish to demonstrate.

Schedule for Maintenance and Operation of Power Department

Force:

Engineer: Head of, and responsible for details of maintenance, operation, etc., of the department.

Day Fireman: Responsible to engineer for details of maintenance and operation of the boilers and their auxiliaries.

Night Fireman and Coal Wheeler: Under day fireman.

Maintenance:

The following operations are to be carried out at the direction of and under the direct supervision of the engineer:

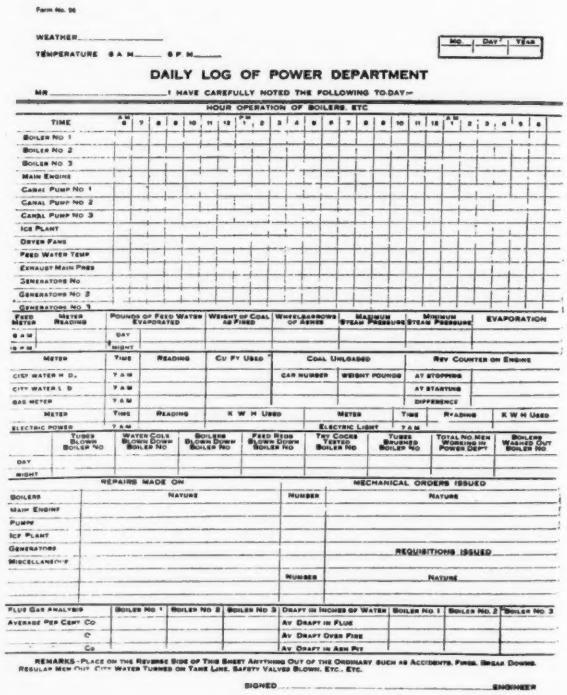

DAILY LOG OF POWER DEPARTMENT
HOUR OPERATION OF BOILERS, ETC
REMARKS - PLACE ON THE REVERSE SIDE OF THIS SHEET ANYTHING OUT OF THE ORDINARY SUCH AS ACCIDENTS, FIRES, BREAK DOWNS, REGULAR MEN OUT, CITY WATER TURNED ON TANK LINE, SAFETY VALVES BLOWN, ETC., ETC.
SIGNED
ENGINEER

FIG. 3. BLANK USED FOR DAILY RECORD OF POWER PLANT

1. Thorough examination of the engine made—every six months.

2. Feed water heaters opened up, cleaned and inspected for leaks—every six months.

3. Feed water regulators inspected and cleaned—every month.

4. Dampers and damper regulators inspected—every month.

5. All windows in boiler and engine rooms washed and repaired—every month, from October to March.

6. Walls and ceilings of engine, boiler and generator rooms cleaned every month.

7. Boiler tops, overhead piping in boiler and engine rooms cleaned—every month.

8. Tool and clothes closets cleaned and inspected—every two months.

9. Boiler settings inspected for air leaks and any leaks caulked—every month.

10. Each boiler thoroughly washed out, examined internally, scale removed and brick work in furnace inspected and repaired—every four weeks.

11. Tubes in each boiler scraped—when boiler is washed.

12. Combustion chamber cleaned—when boiler is washed.

13. All main gages tested and set—once per year at boiler inspection.

14. Fusible plugs renewed—once per year at boiler inspection time.

15. Stacks, interior of boiler, engine and generator rooms painted—once a year.

16. Spare feed pump used for three days—every month.

17. All brass work polished—every week.

18. Safety valves blown and opening pressure recorded on daily logs—every Monday at 6:30 a. m.

19. All tubes blown with steam lance—every Saturday afternoon.

20. Boiler fronts, feed piping, gages, etc., brushed off—every Saturday afternoon.

21. Generators and motors in engine room wiped off and cleaned with compressed air—every Tuesday morning.

22. Fire pump run slowly for one hour—every Saturday afternoon.

Operation:

1. Water columns, gage glasses and feed water regulators blown down—daily at 6 a. m., 1 p. m., 6 p. m., and 12 midnight.

2. Water column try-cocks tested—daily at 10 a. m.

3. Boilers blown down one gage—daily 6 a. m. and 6 p. m.

4. Feed pump and pump governor inspected and oiled, if necessary—every hour.

5. Engine, generators, tank pumps, refrigerating machine, oil separators, and fans inspected, regulated, and oiled by engineer—every 30 min. or oftener if necessary.

6. Exhaust main pressure, open feed water heater inspected and regulated by engineer—every 30 min.

7. Engineer will make inspection of all piping and machinery in his department every day and will issue proper repair orders to master mechanic for all repairs which he is unable to make himself.

8. Recording pressure gage chart changed—daily 6:30 a. m.

9. Feed water meter read—daily 6:45 a. m. and 5:15 p. m.

10. Daily log for preceding day made out and handed to superintendent daily before 9 a. m.

11. Engineer will keep duplicate record of all coal cars arriving, giving date and time of arrival; car number and date and time unloaded. One copy will be turned into the office and the other will be retained by the engineer.

12. Engine wiped off and oil pans cleaned up—daily 12 noon and 5:15 p. m.

13. Fires on all boilers to be cleaned at 4:30 a. m. daily and that on number three to be cleaned at 12 noon if necessary. At times it may be necessary to clean all three fires at 4:30 a. m. and again at 12 noon. This will be the case when running with rice or with very dirty coal. At such times the engineer will call in the necessary extra help from the labor gang.

Hours:

The following schedule of hours will be in force in the power department. All help will be paid on an hourly basis and no overtime will be paid for unless such overtime is O. K.'d by the superintendent or his authorized representative.

Engineer: 6:30 a. m. to 5:30 p. m. daily, except Saturday and Sunday; 6:30 a. m. to 2 p. m. Saturdays and the time necessary to wash boilers or make necessary repairs on Sundays.

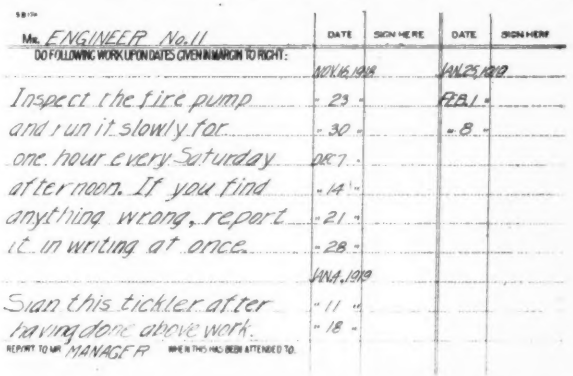
Day Fireman: 5:45 a. m. to 5:15 p. m. daily except Saturday and Sunday; 5:45 a. m. to 2 p. m. Saturdays and the time necessary to wash boilers and make necessary repairs on Sundays.

Night Fireman: 5:15 p. m. to 5:45 a. m. seven days per week.

Coal Wheeler: The same hours as the day fireman.

Special watchman will take care of the boilers on Saturday afternoons and Sundays during the day time.

Steam pressure will always be maintained at or above 50 lb. unless all three boilers are shut down for necessary repairs and then it will be necessary to secure written permission for this from the insurance company.


Mr. ENGINEER No. 11

DO FOLLOWING WORK UPON DATES GIVEN IN MARGIN TO RIGHT:	DATE	SIGN HERE	DATE	SIGN HERE
	NOV 16 1918		JAN 25 1919	
Inspect the fire pump	" 23 "		FEB 1 "	
and run it slowly for	" 30 "		" 8 "	
one hour every Saturday	DEC 7 "			
afternoon. If you find	" 14 "			
anything wrong, report	" 21 "			
it in writing at once.	" 28 "			
	JAN 4 1919			
Sign this tickler after	" 11 "			
having done above work.	" 18 "			

REPORT TO MR. MANAGER WHEN THIS HAS BEEN ATTENDED TO.

FIG. 4. FORM OF TICKLER DEVISED FOR POWER PLANT MANAGER

All men are expected to report at their regular hours as shown above. Any lateness or absence which can be anticipated should be reported to the engineer a reasonable time in advance. In the event of unexpected lateness or absence, the engineer should be notified by telephone or messenger as soon as possible.

COAL REPORTS for recent weeks show a great falling off in production at the mines, largely due to lack of market. For the week of Feb. 8, this lack varied from 2.4 per cent in Alabama to 65.8 per cent in southern Ohio, the average being 40.1 per cent. For the week of Feb. 15, the carloads shipped from mines were 1300 less than for that of Feb. 8, showing a still further falling off of production.

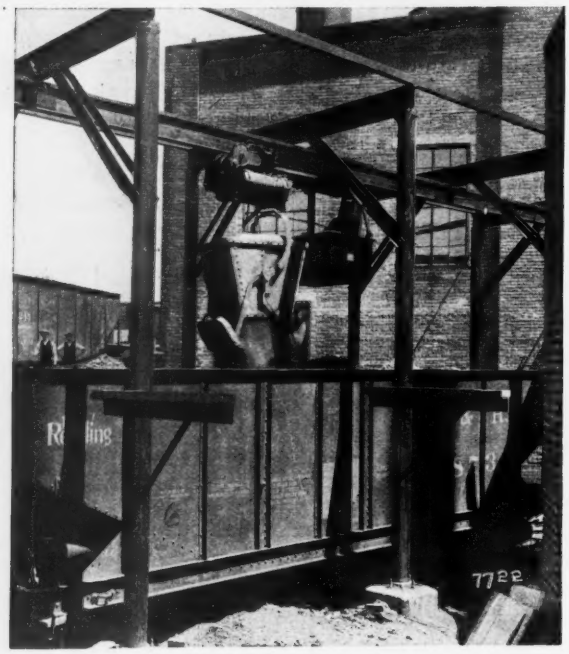
The lack of market is due, in part, to the mild winter, the falling off in government requirements, and the slowing down of industry; stocks which were accumulated in anticipation of a shortage are now being used; but there is also the feeling, whether justified by facts or not is difficult to determine, that prices will decrease, and that it is wise to buy now only what is absolutely essential for immediate use.

Novel Ash Handling Mono-Rail Hoist

By Frank C. Perkins

THE accompanying illustration shows a novel ash-handling electric mono-rail hoist, developed at Philadelphia, Pa., for loading cars and boiler house service.

This mono-rail electric hoist has a bottom dumping bucket, and when used in the boiler room this machine runs on the lower flange of an I-beam track. It is operated by a man traveling in a trailer cage, who controls the raising or lowering of the bucket, as well as the travel of the hoist. The machine in the boiler house passes through the track runs and continues on out over a railroad siding. The laborers who clean the fires, fill the bucket with ashes, and the operator hoists his bucket, and runs it out directly over the car, where he dumps



ELECTRIC MONO-RAIL HOIST DUMPING ASHES INTO CAR

it by the motion of a lever in the cage. The current required is very small, and when compared with wheeling ashes, the saving in time and labor is clear.

At the Manayunk Plant of the Philadelphia Paper Co. about 30 tons of ashes are handled daily in this way, being pulled out every 6 hr. Two men do the work of shoveling into the bucket, and then often one of them gets into the cage and runs it out over the car; at other times, to hurry the work, an additional man operates the hoist, remaining in the cage. The bucket holds 1¼ yd. and is handled by a two-ton hoist.

It will be seen that this machine is very compact and requires little head-room—a most important consideration in an installation of this kind, where it is necessary to get a large bucket over the side of a high side gondola car. All the gears operate in oil, and are entirely enclosed in housings—any other type of machine would not be suitable for handling ashes. In the Philadelphia plant a most satisfactory steel suspension bunker supplies coal to the stokers. In many instances, however, an overhead bin cannot be installed for lack of space.

In some cases it is practicable to use the same mono-rail hoist system to handle the coal as well as the ashes, and a tipping bucket is used to discharge the coal into a stoker hopper or a bucket with a small chute and under-cut gate is utilized.

The problem of handling ashes mechanically is urgent, and many boiler rooms are now running 24 hr. a day where 2 yr. ago they were running 10. Therefore there is more than twice the ashes to handle, and with labor scarce. Many plants have put in stokers and forced draft systems to increase their capacity, often neglecting to provide for the handling of the ashes, when the remodeling is done, and the electric hoists are used to great advantage.

How Many Hours Did It Cost?

A WORKER in an industrial plant who had been unusually successful in saving and maintaining his family and himself in comfort at the same time, gave this explanation of how he got ahead.

"As long as I thought of prices for things merely in money, I never could save a cent, and we had very little to show for what we spent. In terms of money, anything I wanted seemed cheap.

"One day when I was going to spend a dollar foolishly, the question occurred to me, 'How many hours of good hard work did it take me to earn that dollar? The article no longer seemed desirable, and I quickly realized that at the price of two hours' work it was not cheap. Since then I have trained myself to translate prices into working time. Ten cents is 12 min. at the mill; $5 means a day and overtime.

"If you use this system you will be surprised to find how many things you can do without easily and how many other things are not worth the money to you. Even better, pricing things in hours of work helps you to get real solid value for every cent you spend.

"I believe thoroughly that amusement and recreation are necessary to efficiency. But now before we spend for shows or what not, we decide whether the recreation or amusement contemplated would be worth the work it took to earn that fun.

"As a result many a 'foolish' quarter and dollar have gone into thrift and War-Savings Stamps, which certainly pay you full time for your work. We regard the interest as 'overtime velvet.'

"Besides, we have a better home, better clothes, better furnishings, better food and more fun than we did before I began to spend wisely."

IT IS estimated by the Water Power Committee of England that the world's present power demands are for 120,000,000 hp., divided into: Factories, electric lighting and street railways, 75,000,000 hp.; railways and interurbans, 21,000,000 hp.; shipping, 24,000,000 hp.

Of the factory, lighting and street railway division, Great Britain requires 13,000,000 hp.; continental Europe, 24,000,000; U. S. A., 29,000,000 British Dominion and dependencies, 6,000,000; Asia and South America 3,000,000 hp.

Worcester's Fuel Saving Campaign---II

WHERE LOSSES WERE FOUND AND SOME CORRECTIONS. BY S. E. BALCOME

IN THIS article will be given as far as possible the results of the first inspection of the engineers who acted as inspectors for the Worcester Fuel Committee. No names will be given for obvious reasons.

The data from which this is taken are in the form of recommendations from the engineers to the different factories and, of course, are corrections and remedies for faults which were found in these factories and would be found in almost any mill or factory. They are remedies for waste in the boiler room and in the factory buildings. Many of the concerns bought their power and heat, and some factory managers on that account thought that they could not save any coal but it was explained to them that users of power and heat had it in their power to waste as much as those who generated their own power.

SAVING LIGHT

FOR INSTANCE, dirty windows were the cause of recommendations from many of the engineers. These dirty windows naturally forced the factory workers to burn their lights longer in the morning and to light them earlier in the afternoon. It was demonstrated at one concern that at least ½ hr. of daylight was saved per day by keeping windows clean, thus eliminating the use of artificial light for that length of time. Lamps also were not kept clean in many places. Carbon lamps were used where tungsten lamps could have been used, thereby consuming twice as much current as needed.

This is wasteful, and there are times even in the life of tungsten lamps when it pays to discard them and use new lamps.

Dark walls absorb light and many of the factory rooms needed white paint badly. It is surprising what a vast difference a coat of white paint and a coat of enamel will make in the amount of light needed as well as in the general appearance of the room. It not only saves light but makes the rooms lighter in the time when artificial lights are not necessary, thereby helping the operatives to do more and better work. Unused rooms were heated in many shops when they could have been kept at a lower temperature.

Bad distribution of lights was noted also, some factories using large lamps in hallways, and other places where smaller ones would do just as well.

To one concern six recommendations were made, among which were the following: Tighten up engine bearings; try to increase vacuum in the condenser; shut off steam in a number of pipes which are not being used; adjust engine valves and put insulating covering on live steam pipes. In another place, uncovered live steam pipes were found running through cold storage rooms; which is going some.

One source of heat loss which nobody seems to think amounts to much is the uncovered steam trap. Many of them have a large amount of surface, and when used with a medium or high steam pressure there is a considerable heat loss from them. A table shown below and furnished by the Johns-Manville Co. gives the amount of heat loss from bare surfaces of pipes under different steam pressures and the consequent temperatures. This table was used by the engineers to back up their arguments for steam pipe covering.

LOSS FROM BARE SURFACES OF PIPES

FACTORS—100 lb. Steam pressure (Temp. 338 deg. F.). Room at 70 deg. F. 1 lb. of coal evaporates 8½ lb. water from feed water at 212 deg. F. to above pressure. 3 B.t.u.'s loss per square foot per 1 deg. difference in temperature per hour.

TIME—One Year—365 days—24 hours a day.

Bare Surface 100 lb. Steam	Coal loss per year in pounds	Dollar loss, coal at $7.50 per ton
1 Pr. 6 in. Flanges	1854	6.95
1 Pr. 8 in. Flanges	2266	8.50
1 Pr. 10 in. Flanges	2884	10.81
1 Pr. 12 in. Flanges	3296	12.36
1 Pr. 14 in. Flanges	4120	15.45
1 Pr. 6 in. Globe Valve	4120	15.45
100 Lin. Ft. ½ in. Pipe	18128	67.98
100 Lin. Ft. ¾ in. Pipe	22577	84.66
100 Lin. Ft. 1 in. Pipe	28345	106.29
100 Lin. Ft. 1¼ in. Pipe	35844	134.41
100 Lin. Ft. 1½ in. Pipe	41035	153.88
100 Lin. Ft. 2 in. Pipe	51253	192.20
100 Lin. Ft. 2½ in. Pipe	61882	232.06
100 Lin. Ft. 3 in. Pipe	75561	283.35
100 Lin. Ft. 3½ in. Pipe	85696	321.36
100 Lin. Ft. 4 in. Pipe	97067	364.00
100 Lin. Ft. 4½ in. Pipe	107779	404.17
100 Lin. Ft. 5 in. Pipe	119892	449.59
100 Lin. Ft. 6 in. Pipe	142799	535.49
100 Lin. Ft. 8 in. Pipe	185977	697.41
100 Lin. Ft. 10 in. Pipe	232121	870.45
100 Lin. Ft. 12 in. Pipe	280160	1050.60

NOTES:

Loss from 1 sq. ft. of bare surface=824 lb. coal per year. Cost $3.09, coal $7.50 a ton.

804 B.t.u.'s loss per hour, per square foot at 100 lb. steam pressure.

1006 B.t.u.'s in 1 lb. Steam at 100 lb. pressure. (Feed water at 212 deg. F.)

8551 B.t.u.'s in net value of 1 lb. of coal on the above conditions.

LEAKS, STEAM AND COLD AIR

ANOTHER concern: flange joints and other joints in piping leaking badly; safety valve, blowoff valve and whistle valves all leaking, live steam being used to heat some kind of hot plates with no steam traps to check the discharge, and depending on a globe valve for that purpose. The shafting was out of line and the windows were loose and leaky, thereby letting in a lot of cold air. This is the condition in many shops because shafting will run when it is out of line and loose windows are not noticed unless somebody takes especial pains to examine them. By our records a gain of 18 per cent was shown at one concern by lining up the shafting. The

writer does not know whether this is based on friction load or total load, but it is a substantial saving anyway.

In one shop which was visited they were evidently using high pressure steam for heating, as they were advised by the inspector to try to use low pressure heating in the coming winter.

Heating offices by high pressure steam and using a globe valve on the return pipe instead of a steam trap seems to be a common fault with quite a few concerns, and in fact, using a globe or gate valve in place of a trap is very common.

It was found that some concerns who bought power and required direct steam for heating did not save their returns but let them go to the sewer. This is a waste not only of heat, but also of water.

Waste Exhaust

At one concern they were running an engine and heating part of the shop with the exhaust and part with live steam, and at the same time not using all of the exhaust. There was more than enough exhaust steam to heat the whole shop in all weathers, so it was recommended that they buy power for one or two floors and run enough load on the engine to give them steam for heating. This change was made and they reported not only a saving in fuel but some gain in production due to steadier speed. This condition may be found in many factories where the power load overbalances the heating load and only a portion of the exhaust steam is used. This is made all the worse by the fact that the engine probably uses anywhere from 30 to 50 lb. of steam per horsepower-hour.

It was noted in one factory where the heat was furnished by exhaust steam that on account of the exhaust not being sufficient to heat the buildings, live steam was introduced into the system at various points, through reducing valves. These valves were not right in the first place and were out of order in the second place and were letting live steam into the system at the same time that the back pressure valve on the exhaust pipe was open on account of over pressure. (That helps warm the outside atmosphere.)

Direct acting steam pumps were found in not very good order. They are not economical at the best, but when out of order they do certainly consume steam. It was inconvenient to make a thorough examination of the valves and pistons of engines and pumps except in a few places, but where they were examined, badly worn valves and valve seats were found, also worn pistons and follower plates. The pistons and follower plates were worn in the joint between the piston and ring and between the follower plate and ring so that steam could leak through those places freely.

Recommendations to correct all these faults were sent to the chairmen of the shop committees and in practically every case they were followed out and the proper repairs made.

Engines were being run which had not been indicated for a long period—some never—with their valves out of adjustment, shafting was being run not regularly oiled, live steam used for heating water when exhaust would do just as well, etc.

When any engine seemed to be out of adjustment, the inspector would request that the engine be indicated and cards sent to him for examination and criticism.

Boiler Conditions

Boilers in some places were not well taken care of, for instance one boiler visited had not seen a tube scraper for a long time, and when it was scraped the soot came out in long pieces of scale about ½ in. thick. At this time the writer would like to speak of a case which came under the observation of one of the inspecting engineers, but which we would like to say is not a representative condition of boilers in Worcester.

At the request of this visiting engineer, the boiler head door of a horizontal heating boiler was opened. This door had not been opened for a long time and the smoke box was found almost full of soot, covering up part of the tubes. This probably would not happen to a power boiler but is an exaggerated case showing conditions in some heating boilers.

It was recommended in some places where the boiler was too large for the work to be done that the grate surface should be reduced by bricking up part of it. The argument was, that to run efficiently, the rate of coal consumption should be about 16 lb. per square foot per hour, but many boilers were being run which were burning as low as 5 lb. per sq. ft. per hour. Of course, if at a later time this boiler was required to run at a greater capacity, the bricks could be easily removed.

Although Worcester water is very good for boilers, there were some that were not as clean as they ought to be, both inside and out.

Boiler settings were all more or less leaky as to air and needed attention especially around clean-out doors.

Belts and Pulleys

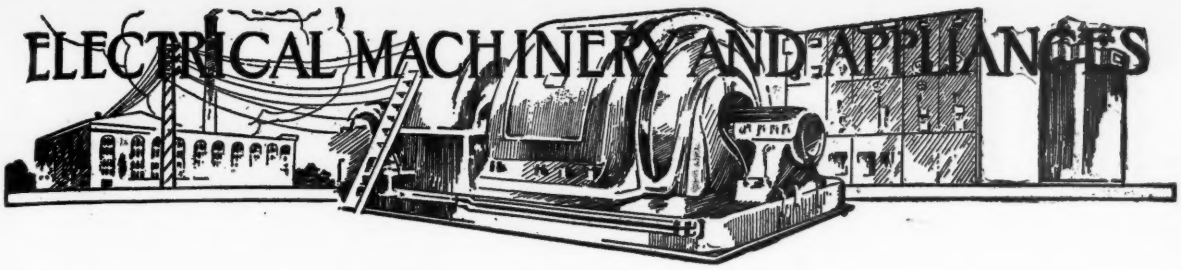
A few concerns were heating their feed water for the boiler in a feed water heater that was too small or improperly managed and feeding the boiler with water not as warm as it might be. Others were neglecting their belts, letting them dry up or running them too slack and letting them slip, thus using power needlessly. A belt should be kept soft by an occasional application of castor oil or other dressing and should be kept tight enough to carry the load without slipping, because a slipping belt causes a double loss, viz., loss in power and loss in production. Shafting was found out of line in many places, and also wooden pulleys which had become worn or pulleys out of line causing the belts to run partly off from the pulley and in some cases rubbing against the wood work nearby.

Motors were found running too lightly loaded, causing a loss at the motor. It was recommended in these cases that tests should be run on the motors to confirm the fact, and wherever they were found to be much underloaded and it was possible to arrange the shafting so that some of the motors could be cut out and the load carried on the others, it was to be done.

While the inspections have been stopped, the desire to save fuel will be kept alive for some time to come by the enthusiasm which was stirred up by the visits of the inspectors and their dealings with the different shop committees.

"Engineer—One who economically directs man power and by scientific design utilizes the forces and materials of nature for the benefit of mankind."

This is the definition handed down by a corps of savants backed by the U. S. government.



Rewinding an Induction Motor

DETERMINING TYPE OF WINDING, STRIPPING ARMATURE, WINDING COILS, PLACING COILS AND CONNECTING LEADS

WHEN an induction motor is to be rewound the first thing to do is to determine the form of connection, whether star or delta. This is done by tracing the leads and jumpers. If there are three wires connected together, and one wire to each main lead, it is a single star; if two wires are connected to each main lead it is single delta. If six wires are connected together and two to each main lead, it is a double star; if four wires are connected to each main lead, it is a double delta, etc.

FIG. 1. MOTOR IN PROCESS OF WINDING SHOWING THE LAST TWO COILS READY TO BE LAID DOWN. A—SLOT INSULATION GUIDE PAPER. B—PHASE INSULATION BEFORE TRIMMING. C—END TAPED TO HOLD COILS TOGETHER AND ALSO FORM A CUSHION. D—LONG LEADS TO FORM JUMPERS, SHOWING SLEEVING IN PLACE

The motor we are considering is a two circuit star (double star) having 72 coils, four poles, six coils per pole per phase, the span is 1 and 15 (see Nov. 1, 1918 issue) and the frequency 60 cycles.

The motor is carefully stripped, and the lamination trimmed to smooth down all rough places in the slots and slot openings, and at least one coil taken out whole for a pattern. A form is made up of wood as shown in Fig. 2, taking care to make the shoulders long enough to allow the coils to enter the slots without the corners striking the lamination, thus endangering the motor to short circuits and grounds. The distance from bend to lamination should not be less than ¼ in. so as to allow

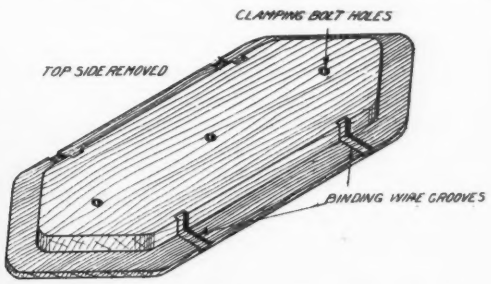


FIG. 2. FORM FOR WINDING DIAMOND COILS WITH SLOTS CUT OUT FOR TIE WIRES

the coils to lie in position neatly without having to hammer them back with a mallet and stick.

A good way to determine whether the coils are made to fit is to make one coil and try it in the motor. If the coil drops in position without undue effort and a reasonable amount of space is left for the next coil to lay in neatly, the coils will be all right. Another important feature is to make the coils straight; there should be

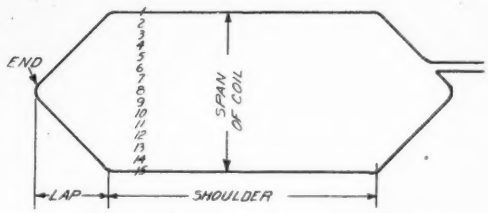


FIG. 3. DIAMOND COIL AND NAMES OF PARTS

no crosses in the turns, because if there are, the coils will not slide in the slot opening easily and they will be subject to damage such as skinning the insulation, cutting or nicking the wires. When a full coil is wound on the form, a tie wire is inserted in each of the cuts made in the form for the purpose (see Fig. 2) and the coil is held together temporarily by them until the full set is made or the ends sleeved and taped.

In order to save wire, make four coils for each group with just enough lead to form the short connections and the other two of each group with long enough leads to

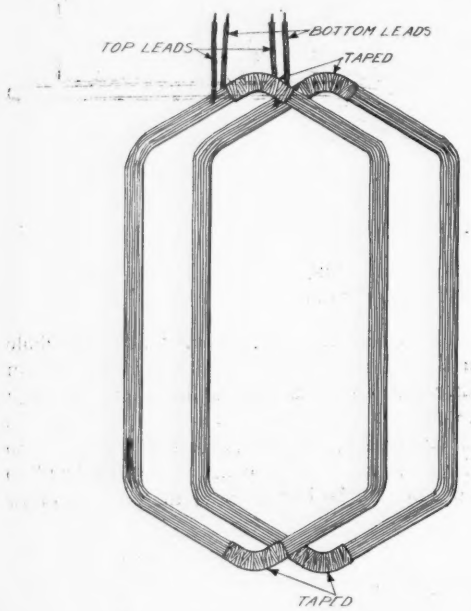


FIG. 4. TAPED ENDS AND METHOD OF BRINGING OUT LEADS

form the jumpers. After all the coils are made, proceed to sleeve the leads just enough to protect them, then tape the extreme ends of the coils, taking care to bring the leads out one above, the other below the coil,

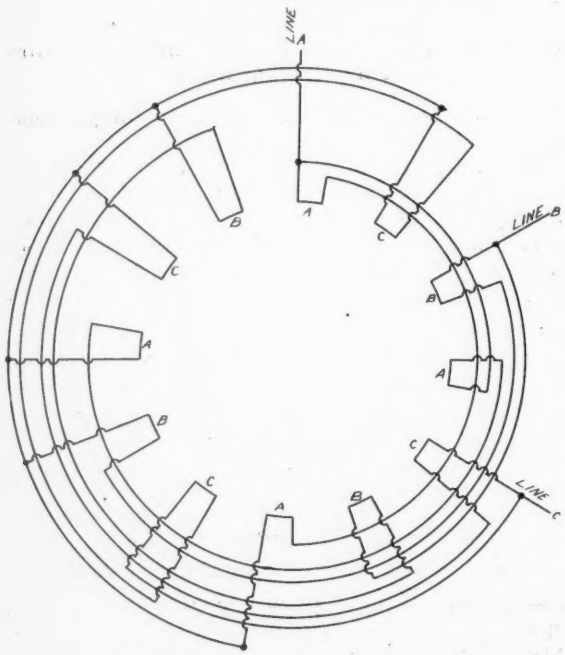


FIG. 5. TWO CIRCUIT Y CONNECTIONS FOR FOUR-POLE MOTOR

as shown in Figs. 3 and 4, not on each side of the end but from the same lap of the coil. By bringing the leads out as explained, the connections can be neatly formed and almost hidden from view. Having all the coils made, the slot insulation is cut and placed in the slots.

The best and quickest way to wind is to place one end of the shoulder of the coil in the slot by first flattening out the coil, then sliding it in the slot with leads down and on the right-hand side of the winder, then the other shoulder of the coil is fed in from the top of the slot. Place each coil in its two slots so as to have them out of the way and as soon as the full pitch or span is completed, which is 15 coils, the sixteenth coil is placed in permanently. If care is exercised it will not be difficult to lay the coils in the slots. When the sixteenth coil is placed, the slot insulation is trimmed on the side where the slot is full, which should be the side nearest the winder, and folded over neatly and the wedge driven in. When two full coils are placed, put in phase insulation and continue this at every group of six coils by sliding the empire cloth in between the coils as you proceed. The phase insulation should be cut square,

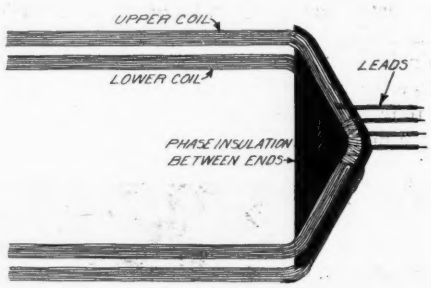


FIG. 6. POSITION OF PHASE INSULATION

large enough to cover the whole top of one coil and folded diagonally, Fig. 6. After the coils are inserted as far as the start, lift up the sides placed in the slots temporarily and proceed with the remainder of the coils until they are all in place. Do not use any metal, such as a hammer or screw-driver, to put in coils or to drive them back; use a rawhide mallet, a thin piece of fibre and a piece of a broom handle flattened out at one end with all sharp edges trimmed. Having trimmed the phase insulation properly, proceed to make the short connections. Then form the jumpers as shown in Fig. 5. Always work away from you and place all coils over the ones already in place. Do not try to put coils in underneath the ones already in the slots until those temporarily placed in at the start are reached.

Impulse Gaps for Lightning Arresters

IMPULSE GAPS for lightning arresters are recommended for use in connection with lightning arresters which protect stations of large capacity operating at 11,000 v. and higher. The impulse gap excels every other known gap in assisting arresters to give protection from lightning and other high-frequency or high-voltage disturbances.

Impulse gaps, as mentioned herein, are for use in connection with electrolytic or other three-phase (grounded or ungrounded-neutral-circuit) lightning arresters now in service. The impulse gap illustrated protects the insulation against high-frequency or steep wave-front surges of high potential at a lower voltage than does any other known gap.

The old-fashioned plain horn gaps had considerable time-lag, allowing a high-frequency surge to rise to a much higher voltage than would a low-frequency surge before discharging and giving protection. The development of the sphere gap partly prevents this by eliminating the time lag so that all frequencies are discharged at the same voltage. The new impulse gap has a negative time lag; that is, the higher the frequency the lower the voltage at which the gap discharges. Thus the impulse gap automatically selects the dangerous surges and

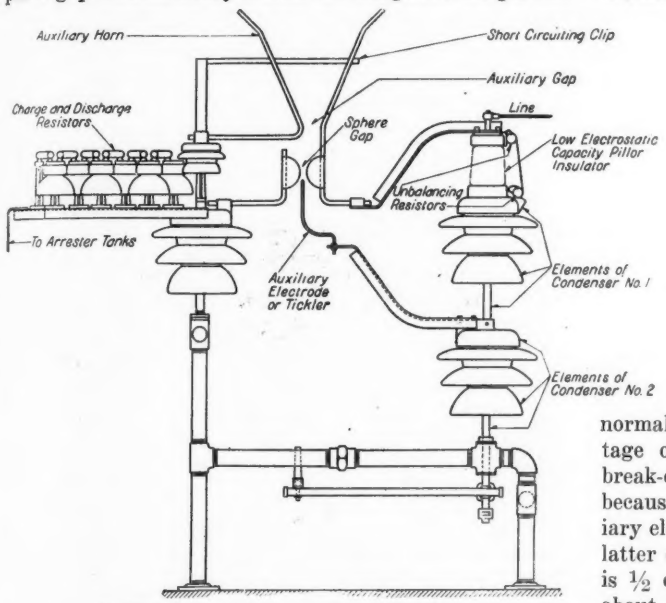


FIG. 1. A TYPICAL IMPULSE GAP

gives protection more quickly than any other known form of gap.

The impulse gap not only incorporates all of the virtues of the horn gap and the high-speed sphere gap, but also possesses the property of selecting high-frequency or steep-wave-front surges and discharging them at a lower voltage than the normal voltage setting of the gap. It should be particularly noted that the impulse gap is the only device which will protect insulation against a steep-wave-front surge of reverse potential,

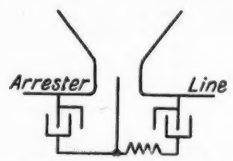


FIG. 3. SCHEMATIC DIAGRAM OF IMPULSE GAP

that is, a sudden drop in voltage. The high-frequency discharge voltage may be as low as ⅔, or even ⅓ of the normal-frequency value. It is, therefore, possible to use a gap setting that will permit of the desired degree of protection against dangerous surges while not permitting too frequent discharging on minor surges at normal frequency.

High speed of the sphere gap as compared with the horn gap is due to the elimination of the time required to build up a sphere of equal-potential surface at the discharge part of the horn gap. The sphere of equal potential surface practically eliminates corona and reduces field distortions when the gap is set equal to, or less than, the sphere diameter. By the use of the sphere gap the voltage to ground, or the break-down voltage, at any frequency does not materially exceed the 60-cycle discharge voltage of the gap; however, the sphere gap does not give the desired protection against steep-wave-front, or high-frequency surges, due to its inability to discharge these disturbances at lower voltage than the normal frequency setting of the gap. It is necessary to set all arrester gaps for a sufficiently high

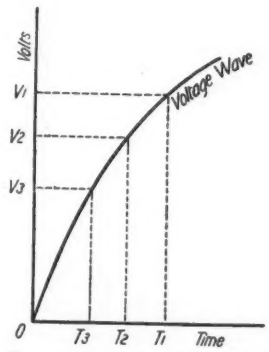


FIG. 2. HIGH-VOLTAGE WAVE CURVE

normal frequency without the corresponding disadvantage of reduced protection, since the high-frequency break-down value of the gap is much lower. This is because high-frequency discharges start from the auxiliary electrode and have only ½ of the gap to jump. The latter electrode, also, is so shaped that although the gap is ½ of the main gap, the break-down voltage is only about ¼ as great: that is to say, high-frequency surges not only delayed in discharging, as with plain horns, by the need of building up a static field; but instead, discharge at a voltage even lower than the normal value of the main gap, since they automatically select the auxiliary gap of much lower voltage break-down.

Figure 2 illustrates this graphically. V_2T_2 represents the point and time of break-down of a properly designed

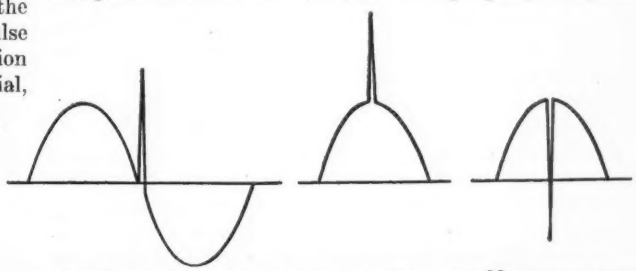


FIG. 4. IMPULSE VOLTAGE SUPERIMPOSED ON 60-CYCLE WAVE

sphere gap which has no time lag. V_1T_1 shows the delay resulting from the time lag of an ordinary horn gap and the consequent greater rise of voltage before the discharge takes place. V_3T_3 on the other hand, shows the earlier discharge and the quicker and better protection resulting from the lower voltage break-down of the impulse gap due to its selective property.

The impulse gap, Fig. 3, uses a circuit that, at normal frequency, is balanced as to voltage, but becomes unbalanced and starts a discharge in the case of any high-frequency surge. At normal frequency there is no difference of potential between the mid-point of the

condensers and the auxiliary electrode midway between the auxiliary horn and sphere gap. A high-frequency, however, passes freely through the condensers and piles up its full voltage across the resistance, that is, across one-half of the total gap. This gap, therefore, breaks down, resulting in the total voltage being impressed on the remaining gap, which breaks down in turn, dissipating the disturbance to ground. The break-down of each half of the gap is facilitated by the fact that the auxiliary electrode is small in size (having needle gap characteristics) so that the discharge voltage of each half of the gap is about ¼, rather than ½, of that of the total gap between the spheres. It should be especially noted that the danger to apparatus from steep-wave-front surges, particularly of reverse potential, may be out of proportion to their actual magnitude, due to the inductance of apparatus, which not only produces a high voltage across the first few turns of the winding of any apparatus, but also a much higher voltage to ground than the normal voltage of the impulse, due to the addition of induced or reflected voltage to the normal voltage of the impulse. If the apparatus is to be protected with a gap and lightning arrester, the gap should be one that will select and discharge the high-frequency disturbances at a voltage lower than the normal voltage of the gap. The impulse gap accomplishes the desired result.

The necessity of selective action in the gap is emphasized by the following possible combinations (see Fig. 4) of the impulse and line voltage. (Assume that an ordinary sphere gap to ground is set to discharge at twice the line voltage.)

Case A—The voltage of the line does not affect the action of the impulse, and the impulse must reach twice the line voltage before the gap protecting the apparatus will discharge.

Case B—The voltage of the impulse must reach only the same voltage as that of the line, before the gap discharges.

Case C—The voltage must have a value three times the line voltage before the gap discharges. In this case, it is to be noted that conditions are such that the high-voltage stress is present not only to ground, but also between turns of windings of apparatus. Adequate protection against this condition demands the use of a gap which is very sensitive to steep-wave-front surges. If the impulse is oscillating, the second half cycle may cause a discharge; but the time for protection against the destructive effect of the first half cycle will have passed.

It is to be noted that with the impulse gap, the discharge begins at a lower voltage than with a sphere gap, and hence, operates more quickly than a sphere gap.

In construction the impulse gap consists of standard (Faradoid and pillar) porcelain insulators (two of which are used as condensers), unbalancing resistor, auxiliary electrode or tickler, a sphere gap, an auxiliary horn gap, a short circuiting clip, a charge-and-discharge resistor, and a supporting framework. The framework is equipped with feet which can be mounted upon an existing structure.

A SATISFACTORY standard for testing valves is to test high-pressure steam valves under hydraulic pressure to three times their working pressure, all other valves to twice their working pressure.

Making Electric Light and Power from Italy's Waterfalls

AN American motoring over the wonderful roads of Italy admiring the matchless scenery is so used, in his own country, to a wealth of electric light that he takes as "a matter of course" the illumination of the streets of the cities and villages, and even the country roads. It does not occur to him that in his own America the electric light is more often than not manufactured by use of coal, while in Italy perhaps the beautiful waterfall or dashing mountain stream he admires is, in some hidden glen, manufacturing the lights

FIG. 1. LA CASCATELLE DI TIVOLI, BEAUTIFUL WATER FALLS OF THE STREAM THAT FURNISHES ELECTRIC LIGHTS FOR ROME

that line his way, or if he takes the railroad instead of a motor, is furnishing the current that propels his vehicle.

The real beginning of the application of electricity as an industry in Italy was marked by the establishment of the plant of the Anglo-Rome Society of Tivoli, for the lighting of the city of Rome in 1892. Since that time the progress has been marked. Plants have sprung up almost like magic in various parts of the kingdom. Railroads that formerly operated by steam power now are electrified at a consequent lessening of expense and independence, as Italy had to import all coal. Industries that formerly operated by steam power are now utilizing the immense water power facilities of their own mountain streams.

German Hold Broken

To quote from one of Italy's scientific writers: "There are now over forty different concerns in Italy operating hydro-electric plants. Some of these companies have a capital of 65,000,000 lire, while smaller ones even as low as 5,000,000 lire."

Ready response of capital favored by liberal legislation has made great development possible, with plants comparing favorably with the largest of the kind abroad, and the unitary cost constantly growing cheaper. Electric energy in Italy promised such splendid returns and bid fair from the beginning to be such an important part of Italy's economic and commercial life that the Germans secured a strong hold upon it, but at the outbreak of the war the Italian government, alive to the danger from that source, not only broke the German hold but has taken up an active water-power policy. Thus many sections of Italy that before seemed hopeless of development in an industrial way are now destined to become very prosperous.

FIG. 2. POWER PLANT THAT FURNISHES ELECTRIC ENERGY FOR ROME AND VICINITY

This transformation has been accomplished without interfering with or marring the landscape. In driving through the valley of the Roja, from Tenda to Ventimiglia, the traveler sees the plants supplying the energy to most of the Italian Riviera and to the San Giuseppe railroad. Passing through the Majra Valley he sees before him some of the most important electric power plants of Europe, supplying energy for operating the Mount Cenis railway. In each of these he has vivid evidence of the phenomena of a wilderness of natural beauty, turning its beautiful streams and water falls into useful industry and wealth without marring the wonderful vistas for which it is noted.

Electric Welding in Europe*

Notes on Electric Welding in Europe Showing the Use of Alternating Current for Resistance Welding and the Carbon Arc as it is Used There. By Capt. J. Caldwell.

WELDING has long been considered as the art of uniting pieces of similar metals by hammering or compression when raised to a temperature short of fusing point, but today a broader interpretation must be accepted to include autogenous soldering in which fusion occurs and any added metal is similar to the pieces to be joined together in firm union.

Resistance Welding

The surfaces to be united are approximately fitted, brought into close contact, and an electric current of sufficient strength passed to bring the surfaces to welding heat. Pressure is applied to force them into contact and to extrude oxide, etc., as far as possible. The heat produced by the passage of the current is greater at the contact surfaces than in the solid metal, because the resistance, even of well fitted surfaces, is much greater than a similar length of solid metal. The heat is, therefore, localized by this fact, and is further localized by using clamping electrodes of low resistance, which hold the work as nearly as possible to the weld. Owing to the rapidity of the heating, and the very small amount of air between the opposed surfaces, very little oxidation can occur. The earliest resistance welding was performed on iron and steel, but it was found that other metals could be welded. For resistance welding alternating current is always used to provide the necessary large current at a low voltage, which is most economically supplied from a transformer adjacent to the welding outfit. It is common to all resistance welding that a comparatively heavy current at a low voltage is required. For this reason alternating current is used, the supply from any available source being stepped down by a transformer which forms part of the welding apparatus.

The secondary winding of the transformer usually consists of a single turn of heavy copper conductor; to this the electrodes are clamped or secured in some way. In most cases the electrodes are specially cooled by water circulation. This is particularly necessary in butt welding large sections where the current runs to thousands of amperes, and the welding takes an appreciable time.

In butt welding it is sometimes desirable to increase the current passing as the welding progresses, in order to keep up the temperature as the contact resistance approaches that of the solid metal. This is readily done by a regulator and an ammeter in the primary circuit of the transformer.

Butt welding is used for joining of wire and tubing

* Abstract of paper presented before the Institution of Engineers and Shipbuilders in Scotland.

in manufacture, cable making, winding of electrical machinery and in chain making.

Carbon Arc

The carbon arc is generally known as the Bernardos system, in which direct current is used. The work is connected to the positive lead, and the negative electrode is a carbon rod fixed in an insulated holder. An arc is struck by touching the work with the carbon, and withdrawing it to a distance varying with the current used. The pressure required is about 90 volts*, and the current from 50 to 500 amp., according to the size of the work. The carbons vary from ½ to 1½ in. in diameter to suit the current. A regulating resistance is used to limit the current, and closer regulation is effected by the worker's control of the length of arc.

The work should be the positive electrode, as that is the hottest part of the arc, and because with the opposite arrangement carbon is carried from the movable electrode to the fixed one, and combines with the fused metal. With the correct connection it is claimed that carbon and other impurities are removed from the iron.

The temperature of the positive electrode of an electric arc is very high. In the case of carbon it is estimated at about 7500 deg. F. In other materials it is limited to the vaporization or boiling point of the metal operated on. It is not necessary to reach such temperatures in welding; the carbon rod is moved along at a rate necessary to obtain good fusion to the necessary depth.

The operator should aim at holding the carbon at a distance which gives a quiet, steady arc. With too short an arc the metal boils and spurts; with too long an arc, the arc wanders, the heat developed is partly wasted in the air, and there is a liability to oxidation of the hot metal. The best length of arc depends upon the current used, therefore, the current needed must be regulated by the resistance in series and not by varying the length of arc.

It does not appear that carbon arc welding is in general use for other than ferrous metals, although copper can be welded by this process.

The carbon arc is used for cutting and holding, sometimes with a jet of compressed air or oxygen to assist the process.

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* American practice is quite generally carried on with metal electrode 15 to 30 v. and carbon electrode 30 to 45 v.

Points on Water Control Valves

Precautions as to Size. Installation and Operation. By M. A. Saller

CONSTANTLY increasing tendency to make power plant equipment automatic in operation has resulted in the extensive use of float operated regulating valves for controlling water supply to tanks, heaters, receivers, hot wells, etc., and it is desirable, therefore, that the engineer be posted on the points and factors which influence the satisfactory operation of these devices.

Probably the most important consideration affecting the life and efficient operation of an automatic water control valve is the matter of selecting the proper size to do the work. If the valve is too large for the quantity of water to be handled, close regulation cannot be maintained because of the very slight movement of the valve required to produce marked changes in the rate of flow. Then again under these conditions the valve is merely cracked for a large portion of the time, and the passage of the water under these conditions will very likely cut and wear the seats. If the valve is too small the supply will be restricted, especially at peak loads, and will be unable to respond quickly to sudden demands for water.

In determining the proper size of a regulating valve, the maximum amount of water to be handled should be ascertained, also the pressure at which it is available. With this information at hand, it is possible to estimate from known capacities of various size valves at different working heads just what the proper size should be. The condensed table herewith gives this information.

In some cases where the range of the load is great, instead of attempting to have one valve take care of the wide variation, an arrangement of two valves and floats can be used, so arranged that the one float and valve placed at a high level takes care of the normal working line; but when it does not supply sufficient water to maintain the desired water level, then another float placed at a lower level responds to the falling water level and brings into operation another regulating valve, which supplements the necessary amount of water.

The average commercial regulating valve will handle most satisfactorily pressures ranging from 10 to 30 lb. per square inch, and if it is found that the pressure or equivalent head of water is greater than 30 lb., a suitable pressure reducing valve should be installed in the supply line ahead of the valve to bring down the pressure to the desired 10 or 20 lb. mark.

In sections where the water comes from streams, and is likely to carry with it leaves, twigs, etc., which naturally would affect the operation of the valve, it is good policy to insert a strainer in the line ahead of the regulating valve, since the clogging of some foreign substance in the valve seat will hold the valve open, and often cause danger from flooding, or in any case a waste of water.

Sensitiveness and responsiveness of the regulating valve, provided it is of the proper size, depend largely on the power and positiveness of the float which actuates the valve; hence care should be taken to have the float of ample size. The leverage of the float arm should be not less than 20 or 24 in., and should be longer in the case of larger valves. The connecting mechanism between the float and the valve should also receive attention at frequent intervals to make sure that undue friction is not being imposed. For regulating valves under 2 in. in size a float ball about 6 in. in diameter should be of ample size. Sizes 2 in. and larger should use a copper ball at least 8 in. in diameter, or an oblate float of equal volume.

The lever on the regulating valve should also be fitted with a counterweight, heavy enough and so adjusted as to counterbalance the weight of the valve parts and operating mechanism so that the power produced by the rise and fall of the float is not dissipated in moving the intermediate connecting mechanism, but is directly available for actuating the valve seats.

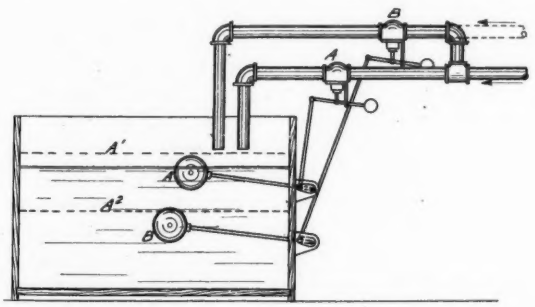
Frequently trouble from faulty regulation can be traced to the packing in the stuffing box on the regulating valve stem, or on the float rod. This should naturally be packed with a good live packing which will prevent leakage with the least amount of friction. Often the packing becomes hard in service and sticks to the valve stem, retarding operation. A bit of lubricating oil will usually eliminate this source of trouble. The packing in the stuffing boxes should be replaced at intervals, and frequently the use of graphite mixed with the packing will serve to prevent trouble from sticking.

TABLE SHOWING PRESSURE REQUIRED TO DELIVER VARIOUS QUANTITIES OF WATER THROUGH DIFFERENT SIZE PIPES

BY G. A. ELLIS, C. E.

Gallons Discharged per Minute	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch	4 Inch
5	3.3	0.84	0.31	0.12				
10	13.0	3.16	1.05	0.47	0.12			
15	28.7	6.98	2.38	0.97				
20	50.4	12.3	4.07	1.66	0.42			
25	78.0	19.0	6.40	2.62		0.21	0.10	
30		27.5	9.15	3.75	0.91			
35		37.0	12.4	5.05				
40		48.0	16.1	6.52	1.60			
45			20.2	8.15				
50			24.9	10.0	2.44	0.81	0.35	0.09
75			56.1	22.4	5.32	1.80	0.74	
100				39.0	9.46	3.20	1.31	0.33
125					14.9	4.89	1.99	
150					21.2	7.0	2.85	0.69
175					28.1	9.46	3.85	
200					37.5	12.47	5.02	1.22

Unless the plant or apparatus is such that it can be



DOUBLE FLOAT VALVE ARRANGEMENT SOMETIMES USED WHEN FLUCTUATION IN LOAD MAY BE GREAT AND SUDDEN

cut out of service at frequent intervals to make repairs and adjustments, the regulating valve should be piped up so that it can be bypassed and cut out of service while the water regulation is being taken care of by hand. The removal and replacement of the valve is facilitated if the valve is of the flanged type so that it can be slipped out of the line without removing any pipe or disturbing the connection.

Where the maintenance of close regulation is essential, or where the water is gritty and rapidly cuts away the seats, the valve should be taken out and ground in with fine emery powder at frequent intervals. If the valve is of large size, it is advisable to purchase a type designed with removable seats.

In connection with the installation of regulating valves, especially those of the balanced type, it is highly important that the valves be placed in the line so that the flow is in the direction for which the valve is designed to operate—usually indicated by an arrow cast or attached to the valve body. If this detail is overlooked, the whole object of the balanced feature is defeated, and the valve will either stick open or stick shut because of the unbalanced pressure on the seats.

Summed up, the securing of satisfactory service from a water regulator or controller will depend on:

(a) selection of proper size valve for quantity and pressure of water available.

(b) sufficient power generated by the float to operate the valve mechanism

(c) keeping the valve seats clean and in good condition by the use of strainers and frequent re-grinding

(d) flowing water through the valve in the proper direction.

Men Are Ignorant of Chances

THE GATES of hope are open for the young men who seem to be hopelessly handicapped by the loss of limbs and other disabilities—marks of the great battle they have fought for humanity. It is the purpose of this country to help them to use the remainder in a way more efficient than before. Veterans of this war will not be social cripples and dependent pensioners, but rehabilitated, self-reliant, and self-respecting men. That was the purpose of the framers of the vocational rehabilitation act passed by congress last June, and carried into effect by a government agency, the federal board for vocational education at Washington.

Every man discharged from army or navy should know of the opportunities offered him. Friends should point out to him that if he is entitled to compensation from the bureau of war risk insurance, he is entitled also to the services of the federal board for vocational education. The board will assist him in finding suitable employment, and if he is hindered by his physical condition from carrying on successfully his former occupation, the board will give him such a course of training —agricultural, industrial, commercial, or professional, as is suited to his needs and preferences.

While he is in training, his family continues to receive the usual allotment, his tuition and other expenses incident to his training are paid, and he is given at least $65 per month for subsistence. If his last month's pay was more than that amount, he may receive an amount equal to his last month's pay. When he has finished his training course a job is ready and waiting for him, probably, due to his newly acquired skill, at higher wages than he ever before earned. His compensation from the war risk insurance bureau is in no way affected by what he may or may not earn.

THERE IS A current belief that dissimilar coals stored in one pile are more liable to spontaneous combustion. The evidence on this point is conflicting, but to play safe, it is advisable to store only one kind of coal in a pile.

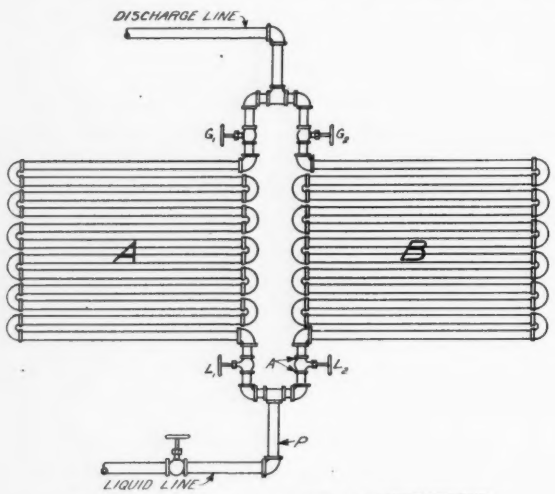
Ammonia Condenser Trouble

By Edward Wolff

AFTER overhauling a 150-ton ammonia condenser during the winter season the operators of the plant began to experience trouble with high condenser pressure when warm weather set in. In fact, the pressure had run unusually high ever since starting up in the spring, considering the low temperature of the water at this time of the year.

Another problem also puzzled the engineers. When they shut down during the early part of the winter there was an abundant supply of ammonia in the system. When they got fairly started again in the early part of the spring, they had to add something like 1200 lb. of ammonia to obtain sufficient liquid in the receiver to make a proper seal over the liquid outlet.

Normally during the warmer part of the summer season they had been able to maintain a condenser pressure of not above 160 lb. During previous seasons, the



THE CONDENSERS AND THEIR CONNECTIONS

plant had not been run up to full capacity; but this year additional load had been added which was expected to bring the load up to about normal capacity of the machine.

Twice during the month of April leaks developed in the condenser that required pumping it out. Each time after starting up, the condenser pressure remained about the same as it normally had been the previous seasons for the same water temperature, as shown by the records, and with practically the same speed of the machine. Also the liquid receiver gage remained full for a couple of hours after starting up again.

After about a half hour run the condenser pressure would begin to crawl up and the liquid level in the receiver gage glass would begin to come down until it finally settled near the bottom of the glass. The operators tried everything they could think of to remedy the trouble without avail.

The writer was finally called in to investigate the trouble. He was informed that the condenser had been purged of air until they were positive this was not the cause of the trouble, that the condenser had been thoroughly blown out with steam and air during the winter and the water pipes had been bored out clean with a turbine cleaner so that the condenser apparently should have been in better condition than it had been since it was first installed.

We finally went up on the roof to take a look at the contraption. The first thing that attracted my attention was that one section of the condenser was unusually hot while the other was cold, and sweating as a cold water pipe does in damp weather. The condenser, it may be noted, was made up of two sections connected to common headers, both on the gas and liquid sides.

This gave a clue to the trouble, as I had experienced somewhat similar problems before. It was evident that the cold section was not doing its share of the work, if any at all, because a condenser in normal operation will feel quite warm to the hand, especially at the top of the coils, while this one was cold clear to the topmost pipe.

The accompanying sketch illustrates the connections. Each section, it will be seen, had a separate gas and liquid stop valve, G_1G_2 and L_1L_2, by which either section could be cut out, if necessary, and the system operated with only a single section of the condenser.

Giving the engineer instructions to go down to the engine room and watch the condenser pressure, I first shut off the liquid valve of the section B, which was the cold section, and then slowly shut off the gas valve G_2 on this section. After waiting for about 10 min. and noting by the sound of the discharge line that the machine was still running at normal speed, I went down to the engine room.

Practically no difference had been noted in the condenser pressure.

However, the pump out connections to each coil on this section were opened up and we commenced to pump down the troublesome section. Gradually the liquid level in the receiver gage glass crawled up and finally it was full with still no sign of frost on the dead section of the condenser. When pumping out a double pipe condenser, frost will always appear on the lower pipes when the coils are getting pretty well pumped out.

Shortly after this, the condenser pressure began to crawl up rapidly, indicating that the working section was filling up with liquid. We disposed of this, however, by shutting off the suction valves on a couple of the largest expansion coils and allowing the excess liquid to accumulate in these. In this manner we were able to keep the liquid level in sight in the gage glass until the frost on the dead section indicated that it was getting fairly well pumped out.

I had a suspicion that there was an obstruction in the connection between the liquid header of the dead section and the main liquid line P. I had remedied this in similar cases by pumping down the coils and then opening the liquid valve, thus reversing the flow through the connection; consequently this was tried.

I opened the valve L_2 in the connection very quickly, expecting to clear the line suddenly. I was very much surprised, however, when not the slightest sound was heard, as any time when a valve in a liquid line is opened where there is a large pressure difference be-

tween the sides of the valve there is a sound similar to that in a water line when a valve is opened where there is a large difference of pressure.

I next tried the gas valve G_2 on this section. Here the results were different. The moment the valve was cracked off the seat the sharp whistling sound left no doubt that the gas was rushing into the coils. When I came down to the engine room again, the condenser pressure had fallen to 150 lb.

We tried the same stunt several times without results. Finally we decided that the only thing to do was to pump the troublesome section out entirely and open up the liquid connection between the section and the liquid line. This was done and we then proceeded to remove the troublesome connection.

Here we discovered what is probably one prize "bonehead" in this line of work. Upon disconnecting valve L_2 we found that a piece of asbestos sheet packing had been placed between the flanges on each side of the valve, and that the center had not even been cut out, so that there was no possibility of the liquid passing through.

This was not all by any means; the valve flanges had a tongue and groove joint but the valve was reversed so that the tongue of the valve met the tongue of the tongued flange and the grooved side of the valve met the groove of the flange. How the joints ever remained tight is rather a mystery to me, but they did, nevertheless, even under the excessive condenser pressure. After the valve was reversed, new gaskets inserted as they should be and the system started again everything went along as it had normally done in former years.

Operating Absorption Machines

CAUSE OF BOIL OVER. EFFECT OF LEAKS IN THE EXCHANGER. GAS IN THE COOLER. FROZEN BRINE COILS. BY J. H. LAMAR

LIKE any other machinery, an absorption ice plant requires attention and study; but with these it is about the easiest of the ice machine family to live with. Parts which require special attention are the rectifier of the exhaust steam type and analyzer and rectifier of the live steam or high-pressure type.

If the rectifier is not getting enough water, you will make wet gas, so that your tank will soon be acting as an absorber, and first thing you know the generator charge will get so weak that it will begin to boil over and add more trouble to the already high temperature of the tank.

What to do then? Well, about the best thing is to cut down the supply of steam to the generator, open the expansion valve more; then blow out of the tanks the rich liquor that has accumulated, and get the ammonia back into the absorber and generator. This takes time and patience, and may make the engineer want to throw up his position. A bad analyzer on the live steam type, or a bad separator between rectifier and condenser, or too weak a charge may also cause boil overs so that the drain pipe cannot take care of the excess moisture. The remedies are of course an overhauling or rebuilding of the analyzer, replacing the separator or strengthening the charge, according to what is found to be the cause of the trouble.

Another point that needs watching is the exchanger, where a very small hole in the poor liquor pipe will cause trouble and loss of capacity. Watch your gage. A leak will cause the high pressure to fall, the low pressure to rise, and the rich liquor will get weak. Try it with a hydrometer; it ought to leave the pump at 26 deg. Beaume with the pump working 26 r.p.m. And poor liquor should come back at 17 to 18 deg. Beaume. If the poor liquor shows 21 to 22 deg. Beaume and head pressure is low, look out for leaks. To make a test, draw the rich liquor from the exchanger, put in water and turn the poor liquor discharge into a drum. If there is a leak, the poor liquor will run down in strength. In one test, under such conditions, the poor liquor line soon showed pure water, and the return bends where the rich liquor passed around them were found to be honeycombed with holes.

Watch the brine cooler also. Be sure that only anhydrous liquid goes to it. If dry gas goes over, the cooler acts as a condenser; the return gas line will be nice and dry, but temperature in the cooler will rise. Again if the brine gets weak, the cooler tubes may freeze up, which will be shown by the low gage pressure falling rapidly.

The quickest way to thaw out such frozen coils is to blow out the anhydrous from the cooler by opening up the purge line between the gas valve and the cooler, first closing the valve leading from cooler to purge line. Connect on air pressure, open the expansion valve wide and put pressure on top of the anhydrous, forcing it back into the ammonia receiver. Then close the expansion valve.

Next blow air from the ice hoist hose over the tubes using a ¼-in. pipe bent at a right angle at one end, keeping the agitator in the brine tank going full tilt; and in a short time ice and slush will come out of the cooler in fine shape. Keep it up until the cooler coils are all clear of slush, then take off the air and readmit anhydrous to the cooler, purging out the air that remains. But be sure to strengthen the brine, as this freezing of brine coils is liable to burst the coils if not caught in time.

Be sure to have good screens in front of the openings to the cooler and have them cleaned once a week.

The writer would suggest that when making repairs, steam lines be connected to the headers on double-pipe condensers, and absorbers so that the coils can be blown out several times in a season. This keeps the coils clean, and insures greater capacity. If steam is not available, air may be used for blowing out, though the writer has found that steam works better on double-pipe coils. Air will work well on tubular absorbers.

Blow only one coil at a time and do not shut off ammonia valves.

Be careful about filling any closed vessel full of ammonia. During the past winter a large plant was shut down with the receivers full of liquor and the valves closed. When the spring sun got around and struck those receivers, both of them blew up, causing a loss of some $5000, besides the ammonia wasted.

In the discussion it was stated that 90 per cent of the trouble in absorption plants comes from having the charge too weak.

* From a paper before the N. A. P. R. E.

Accident Prevention*

PRACTICAL METHODS FOR USE IN SMALL PLANTS. BY WILLS MACLACHLAN

AS a matter of common humanity, as well as a money-saving precaution, every possible provision should be made to prevent accidents to workmen. It is as important in a small plant as in a large one; even more so, for the injury of one good man from the operating force may cause serious disarrangement of the routine work as well as entailing an expense for damages that will loom large in the year's outlay.

In the small plant, the work of education will be largely done individually, and the methods used should be elastic to permit of changes to fit each person. But in any case "Don't Bluff". Say what you mean, and act as if you meant it, so that the men will have reason to follow you and back up your efforts.

Accident prevention is in part for the benefit of the workmen, to save them from injury; but there is also the interest of the company in avoiding interruption to service and saving money, and it is better to be frank about

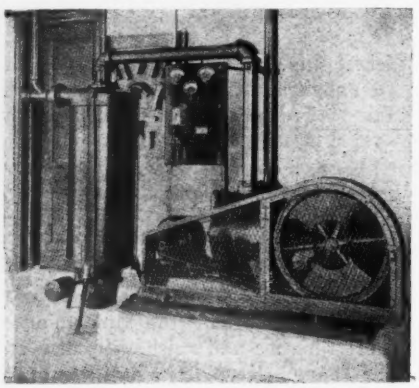


FIG. 1. WIRE MESH GUARD FOR BELT AND PULLEYS

it, and to try to show them that the work is for the benefit of both company and employes, and that cooperation is necessary on both sides.

MAKE ONE MAN RESPONSIBLE

RESPONSIBILITY for methods and for observance of safety precautions should be put on one man who is interested and who will study the subject so as to become an expert. It is not likely that all his time will be devoted to it, but it should be a part of his regular duty, not a side issue. He must study the work of all the departments so as to deal intelligently with details and know where danger lies. When he meets a lineman, he should know the right way to put on belt and spurs and the details of line work; also the dangers of pole work and of handling live wires. This knowledge of details will give sureness to his judgment and win the confidence of the men.

MAKING A START

AS A FIRST step, go over the accident record as far back as possible and tabulate the kind of accidents, departments, causes, kind of injury, extent of injury, lost time—so as to have the facts on which to base an appeal for carefulness.

Next, go over the plant. Assuming a hydraulic plant with transmission line and substations this might go as follows; as to the outdoor plant:

Is the dam safe? Should it be guarded to protect employes or the public? Is the stop-log winch O. K., or should the gears be protected and men warned about danger from the winch handle? Should there be a guard timber along the edge of the platform over the trash racks, to give a foothold when cleaning in icy weather?

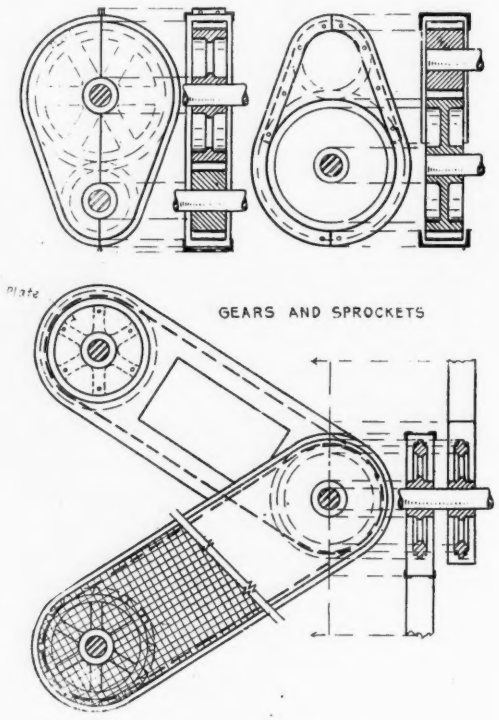


FIG. 2. WIRE MESH COVER FOR GEARS

Are life lines and buoys provided where men work above fast-moving water? Are pike poles handy?

IN THE POWER HOUSE

FIRST AS to turbines: Have governor and oil-pump belts a wire mesh guard? Are flyballs and governor gears safeguarded? Are crown gears, if any, enclosed? Are moving parts guarded so that bearings can be safely inspected? Are there guard rails around generators and exposed high-voltage leads?

On the switchboard: Are disconnecting switches provided between the oil switches and busbars, and between oil switches and outgoing feeders so that current cannot be accidentally thrown on apparatus or a line on which men are working, by tripping a wrong oil switch? Are fuses on motor transformers easily accessible? Are

* From a paper before the Congress of National Safety Councils.

switches distinctly named on both front and back of switchboard? If disconnecting switches are close together, are asbestos baffles provided between them? Are there disconnecting switches between lightning arresters and the line? And barriers between different banks of arresters to safeguard men making repairs or adjustments? Are arrester tanks grounded? Or screened and the screens grounded? Is the operator safeguarded from stepping back into live apparatus when throwing a disconnecting switch?

An important point is to have two means of exit from behind all switchboards, from switch galleries and switch cell structures to give the operator a chance in case of short circuit.

All belts and gears should be guarded or enclosed; stairways should be safe with adequate hand rails, and passageways should be lighted. Examine all tools. Burred drills should be dressed and burred or rounded sledges trued up. Rubber gloves should be gone over inside and out, and if in bad condition, as is usual, condemned. Buckskin covers over rubber gloves will give mechanical protection and increase the life of the rubber.

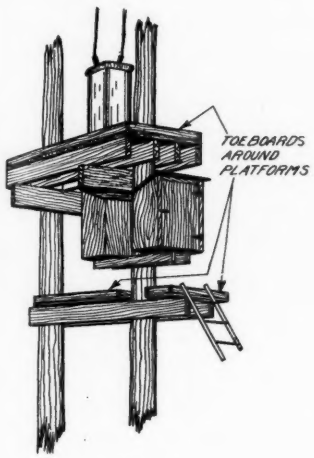


FIG. 3

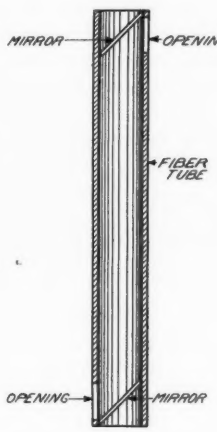


FIG. 4

FIG. 3. POLE PLATFORM WITH TOE BOARD AROUND EDGE
FIG. 4. FIBRE TUBE PERISCOPE

For systems using high tension, telephone stations should be guarded with insulated stools or cabinets, and operators trained to use the receiver correctly to guard against deafness from severe noise.

Attention should be given to safe renewal of lamps and fuses, especially if near high-voltage apparatus.

Transmission Line

Going out with the patrolmen: Do we find provision for grounding the line just outside the power house, by grounding switches, clamp or chain? Do the patrolmen carry two sets of grounding clamps or two chains? Preferably the former.

Now looking at the switching tower, if this has a platform, is it provided with a toe board around the edges? If the switches are operated from the ground by a chain or rod mechanism, is this grounded? Is it held locked in both open and closed positions? And are both positions clearly designated and the name or number of the switch clearly marked?

Substation

Grounding, disconnecting switches and switchboard call for the same examination as in the power house. Inspection of doors and windows should be made to be certain that nobody can enter without a key. And if doors are left open in summer for ventilation, wire doors, securely locked, should be provided.

Risky climbing of a step ladder to read transformer temperatures may be eliminated by using a periscope made of two good mirrors and a length of fibre conduit.

If unskilled attendants are to be sent to the substation at intervals, instead of having a regular attendant, particular attention should be given to safeguarding those places where changing meter records or simple switching may necessitate his going.

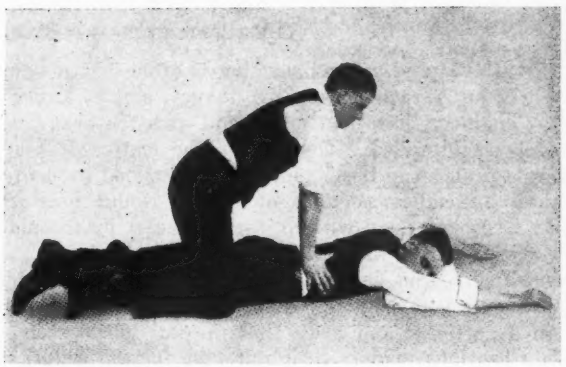


FIG. 5. PRONE METHOD FOR RESUSCITATION. a. FIRST POSITION, PRESSURE OFF. b. SECOND POSITION, PRESSURE ON. (From First Aid Manual by Wm. J. Swift, M. D.)

Clean Up and Inspect

In a steam plant, the same precautions should be taken as to belts, gears, hoists, hot piping and tools as in the hydraulic or electric end of the plant. And especially "good housekeeping" should be insisted upon, for dirt and rubbish go with carelessness and will breed lack of caution.

Finally, study all apparatus to make sure that there is room around it for safe operation. Insist that tools be periodically inspected, and put in good condition by

dressing off burrs and splinters, tightening up hammer heads and loose nuts, testing fire pails, extinguishers and hose, and trying guards to make sure that they are firmly in position. Rubber gloves should be given particular attention along with linemen's equipment, for poor condition of these tools is sure sooner or later to cost some man his life.

When working where a bad flash may occur, as in changing fuses, or disconnecting a switch with a short stick, goggles should be worn which are non-inflammable, nonconducting and as clear as possible while being opaque to the violet rays. Often a man's eyesight will be saved by such precaution.

First Aid

Every plant should have a first aid outfit, the completeness depending on the time required to get a doctor. The best first aid is a competent doctor, and he should be sent for at once in case of any except the most trivial accidents. Even such cases should be seen by a doctor as soon as possible to avoid undesirable consequences.

A simple outfit should contain boracic acid tablets, ginger tablets, carron oil, aromatic spirits of ammonia, iodine in a bottle or better in ampules, castor oil for the eyes, gauze bandages of various widths, triangular bandages, gauze for compresses and absorbent cotton. These should be in small sealed packages so that only those to be used at once will be opened. Brief, clear instructions for treating wounds, bruises, severe bleeding, burns and for applying splints should be placed near the outfit and attendants given instruction and questioned from time to time. Also every employe should be given a copy of the instructions and be shown the outfit so that he will understand what each article is and how to use it. Actual demonstrations of the use are the most practical method of teaching and make the most lasting impression.

Prone method of resuscitation should be taught and regular practice given at intervals until each man does it correctly. Then have an occasional practice, say every two weeks.

Training the Men

Meetings should be arranged at which talks can be given and discussions held, not only on first aid, but on the reason for safety precautions, the best and safest way of handling the plant machinery and making repairs, grounding and removing grounds, cutting machines into and out of service, inspection on changing shift and the reason for the safety rules adopted.

Encourage the men to make suggestions on safety and on operation. Try in every way to secure their interest and support, as the best plans in the world will be of little avail unless the workmen realize that they are for the purpose of avoiding loss and suffering, and are with you in carrying them out.

Line Shaft Troubles

Their Detection and Elimination. By C. C. Hermann

Turned and ground shafting is often looked upon as an extremely expensive luxury, and as a result engineers have had to contend with the next best, namely, cold rolled. Then again, the matter of bearings, a problem in itself and little understood by many, causes an endless amount of grief. Roller bearings may be looked upon with a yearning heart by the man in charge and with frowns by the management. The same fellow who demands the best of bearings in his automobile will deny the same privilege to his production department and insist that the low initial cost of plain bearings justifies their purchase for the wheels of industry.

In time past 150 r.p.m. for the line shaft was considered the limit of speed. Perhaps many still hold to this; at least there are many such installations still in existence. With the price of every article going skyward, the engineer must look about for a chance to save. Some do not need to look. A very material saving can be accomplished in boosting the line shaft speed on new installations at least. Main shaft speeds of 350 r.p.m. and up are becoming common.

In order that a shaft may run well at the higher speeds, it is necessary that it be true; that is, in perfect alinement, level and properly balanced. Each section must be straight and each coupling, if of the flange type, must be properly balanced, put on the shaft and its face turned in a lathe. Every pulley on the line must be properly balanced and the belt pull as nearly equalized as possible. At the lower speed, shafting with a small kink in it did no harm; but at the higher speed, these shaft wabbles are communicated to the building structure and are a detriment to satisfaction and safety. Cold-rolled shafting, although having greater strength, invariably contains kinks, and the advantage of turned shafting lies in the fact that it is true until made otherwise by rough handling.

As a comparison of turned and cold-rolled shafting, Jones & Laughlin Steel Co. gives the following: For turned shafts as second movers or line shafts with bearings 8 ft. apart, horsepower $= \frac{d^3R}{90}$ where d = diameter of shaft in inches and R = revolutions of shaft per minute. For cold-rolled shafting as second movers or line shaft with bearings 8 ft. apart, horsepower $= \frac{d^3R}{70}$

Using these formulas for a basis, we may investigate the horsepower transmitted by a given diameter of shaft at high and low speed. Assume a shaft 3 in. in diameter running at 150 r.p.m., the horsepower transmitted would be, for turned shafting 45 and for cold-rolled shafting 58, while with the same shafting running at a speed of 350 r.p.m. the horsepower transmitted would be for turned sharting 105 and for cold-rolled shafting 135. This indicates a margin on the side of cold-rolled shafting of 13 hp. in one case and 30 hp. in the other. Experiments by Prof. R. H. Thurston showed that cold-rolled steel bar of full size had a maximum strength

of 82,200 lb. per sq. inch, while the maximum strength of hot-rolled steel bar of full size was 62,900 lb. per square inch. It is apparent then that by increasing the shaft speed the shaft diameter can to a certain limit be decreased and a further decrease can be obtained by using cold-rolled. The limit, however, is found by checking the shaft deflection. Kimball and Barr say "the deflection should not exceed 0.01 in. per foot of length to insure proper contact at the bearings." Receiving and transmission pulleys should always be placed as close as possible to bearings, and the distance between bearings should not be greater than would give a deflection of 0.01 in. per foot length. Kent's Handbook states that "the bending stress in shafting does not reduce in the same ratio as the torsional stress, which is inversely proportional to the velocity of rotation." It is therefore self-evident that in designing the line the diameter of the shaft must be checked for bending stresses, taking into consideration the weight of shafting, pulleys and belt tension.

By increasing the speed of the line shaft to say 350 r.p.m., the counters may be run at around 650, thus taking the machine at an easy advance in speed ratios. Smaller pulleys can be used on the main shaft, again reducing the diameter of the shaft since weight is being removed.

In the matter of belting the saving may or may not be considerable, depending entirely on conditions. Considering a main shaft running at a speed of 150 r.p.m. and driving through a counter a machine running at 1200 r.p.m. using a counter shaft speed of say 600 r.p.m. the belt would transmit, if double ply, 1.89 hp. per inch of width using a 48-in. pulley on the main and 12-in. drives on the counter. Now taking the main shaft at 350 r.p.m. the counter speed at 600 r.p.m. and the machine speed 1200 r.p.m., a double ply belt would transmit 1.89 hp. per inch in width using a 20-in. pulley on the main shaft and a 12-in. driver on the counter. The saving in leather is proportional to the diameter of the driving pulleys on the main shaft, which in this case would be 3 ft. 8 in. of belt. For one driver, this is not much, to be sure; but it represents a saving that can be accomplished all along the line which will soon run up into hundreds of feet, depending on the number of drives.

Regarding some of the troubles encountered in cold roller shafting, the writer once installed a 3 7/16-in. line shaft 80 ft. long for mill work. The shaft was cold rolled and flange couplings were used. The shafting was purchased under specifications and came on the job with the couplings keyed on. The first thing that attracted attention was the fact that the concern had shipped common black iron machine bolts that were at least 3/16 in. under size for the couplings. These were very promptly returned and turned bolts secured in their place. It is important that the coupling bolts fit the holes accurately so that the load may be evenly distributed. After the shafting was erected the power was applied and at each coupling an eccentricity varying from 1/8 to 1/2 in. was present. The speed of the shafting was 370 r.p.m., and the vibration was intense. In order to determine the cause and to verify my suspicions I had the shaft disconnected and each section run separately. It was discovered that the shafting was not only badly kinked, but that not one of the couplings had been trued on the shaft but had just been driven on and shipped. The entire line had to be removed, sent into the machine shop, have the shaft straightened and the couplings turned in the lathe. After erecting the shafting a second time it ran very satisfactorily.

A good way to check a line shaft for level or alinement is to remember that if the shaft works endwise, that is, tends to screw out, the shaft is either not level or is out of alinement. If it wabbles with little or no endwise motion, the shaft has a kink in it which can be removed by placing it in a lathe and chalking high spots, after which it may be straightened by the use of a bender. Very often a shaft can be straightened in its bearings by the use of a bender or by peening the low side with a heavy hammer and a lead sheet.

Americanization

ONE immediate and urgent problem for our country and our industries is the amalgamation of all the people into one American nation. A barrier that must be removed is lack of knowledge of the English language, which is our national language, spite of the fact that 10 per cent of the men drafted into the army could not read or understand orders and commands given in English.

Various methods are suggested for overcoming this obstacle. Evidently public night schools and factory schools are needed where a considerable number of non-English speaking people are to be helped. Use of English only by foremen in giving instructions and orders will be an added incentive to workmen to learn English. Friendly help of fellow workmen will rapidly do away with difficulties, and publication of lessons in English and a considerable number of articles in English in foreign language papers will assist materially.

In Cincinnati the American House has been opened as a social center for those of foreign birth, the articles including instruction, recreation and associations, all carried on to aid in learning our language and customs, but conducted in a spirit of fellowship and good will.

Manistee county, Mich., has arranged a program for "get together" meetings through the winter, where talks on duties and privileges of American citizenship will be given and instruction in English furnished.

In Connecticut a law has been passed making it compulsory for all foreign born under 21 yr. of age who are not in school to attend night school in the district where they reside. While such a law is of doubtful wisdom for general application, conditions are such in Connecticut, because of the great number of foreign born in the munitions and arms factories that such a measure may be a necessity.

Cleveland, O., has provided for a text book in foreign languages, with English translation, descriptive of the history of the United States, its great men, its ideals, and its advantages. Native-born Americans are urged to become acquainted with the history and customs of the countries from which their foreign associates have come, so that there may be better mutual understand-

ing. Also to discountenance the use of disagreeable nicknames for foreign nationalities. Foreign-language papers are to be urged to print articles and advertisements in English as well as their own language, to assist the transition of the foreign-born to his new language. It is to be urged that in all elementary schools only English be used. During the year 22 firms have established classes in English and 14 are paying in full or in part for the time spent by employes in these classes.

Detroit is promoting classes in English, encouraging attendance at evening schools, assisting firms in Americanization work and conducting a free information bureau to give help in all questions from citizenship to domestic difficulties.

Firms doing special work are the L. Candee Co., New Haven, Conn., which conducts Americanization classes, an hour and a half in length, pays each pupil attending 25 cents a session, and asks its foremen to use only English in the shop. Eastman Kodak Co. has persuaded every foreign-born man employe to take out first naturalization papers, and many of them to attend evening school. Norton Grinding Co., Worcester, Mass., has classes in English twice weekly during regular working hours, and pushes the co-operative spirit through its paper, the "Norton Spirit."

U. S. Metals Refining Co. of East Chicago, Ind., is using moving pictures at the noon hour, also addresses, to encourage the Americanization idea. An Americanization day was held, attended by all employes, at which addresses were given by the mayor in English and by officers of the Polish and Italian armies in their native tongues, all urging the study of English and of American customs.

At Chester, Pa., the Chester Shipbuilding Co. has organized classes in conversational English, reading and writing, arithmetic, citizenship and shipbuilding. A deposit of $1 is required on entering a course, and is returned when the course is completed.

American Rolling Mills, at Middletown, Ohio, offer prizes to the children of foreign-born parents for the best letters written to their parents giving reasons for learning the English language and becoming American citizens. These letters are used by the educational department of the company in promoting attendance at its classes. A reading room and branch of the public library are maintained at the plant.

Solvay Process Co., Syracuse, N. Y., has recently published a report by Chas. H. Paull showing its work, the relative merit of methods used and the fundamentals for education in Americanization.

Prizes have been offered by the Cleveland, Ohio, Americanization Committee for the best essay by a sixth grade pupil on "Why My Parents Came to America"; the results have been most interesting, and these and other essays gathered in various ways indicate to him who reads carefully that if we will but go at this task of Americanization with open mind and in a friendly spirit, besides helping the foreign-born man to grow into a real American citizen, we shall find that there is much we may learn from him.

BETWEEN TWO coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected for storage.

What Shall Be Done With Our Ships?

TO investigate the shipping situation, Harry A. Wheeler, president of the Chamber of Commerce of the United States, has announced the immediate appointment of a committee, to include shipowners, shipbuilders, shippers, agricultural and industrial interests, lawyers and railroad men. The questions to be investigated are: Shall the Government continue to own and operate the ships now in its possession and under construction? If not, shall it charter ships to operators? If ships are sold, shall the extra cost of emergency construction be absorbed by the Government so as to admit of competitive operation? What changes in regulations or laws must be made, and what charges other than difference in cost must be met to assure success in competitive operation? What tonnage would be available for sale to private owners, and on what terms could sales be made? What division of tonnage should be made between ocean, coastwise and lake shipping? If the Government operates, what regular shipping routes should be established, and what kind of "tramp" service built up?

The endeavor is to be made to find out what the country wants, and the inquiry will be conducted with the approval of Chairman Hurley of the Shipping Board. Those wishing to express their views should write to the Committee on Shipping Policy, Chamber of Commerce, of the U. S., Washington, D. C.

Conservatism in England

BEFORE English officials will order a plant they insist on seeing one of the same size in actual operation. A case is cited of Americans, years ago, ordering a 25,000-kw. set in England on the knowledge of what similar machines of a much smaller size were capable, and now American manufacturers are preparing to produce sets of 75,000 kw., whereas England has not yet put a set of 25,000 kw. into operation.—SCIENTIFIC AMERICAN.

A MAN OF THIRTY, whose previous occupation required the handling of logs and heavy machinery, but who had read books on engines and electricity, is being given a course in electrical station operation, because an injury to his back, due to shrapnel, makes heavy work impossible.

A stone mason, with some knowledge of stationary engines, lost his left arm at Chateau Thierry, and is being given training in gas and stationary engine operation.

The government will give to those handicapped men who need and desire training before going into employment, so much education, at the expense of the federal government, as the man may need; provided, of course, that his claims are reasonable and that his previous training and the nature of his handicap are such as to make further training profitable. The great majority of the returning soldiers do not know of the generous provisions made by the government for their future welfare. By writing the Federal Board for Vocational Education, Washington, they will be given all information.

Industrial Readjustment

ONE OF the most important questions in the present situation is how to minimize differences between employers and employes. It is obvious that strikes, lockouts, closing down of plants, disputes which result in unfriendly relations between the employer and the man on the job are harmful to the interests of both. They result in a loss of product and in loss of wages.

In nearly all lines of business, especially in those plants which have been working on government contracts, the wage scale has been increased to such a point that it is at least doubtful whether it can be maintained when working on commercial products for a competitive market.

In the face of high prices for food and clothing, conscientious employers are in a dilemma. To reduce wages is likely to work a hardship on employes, yet payment of the present rates means that manufacturing will be done at a loss, which cannot long be carried or the business will face bankruptcy. That will result in workers being out of a job and having no wages, which is certainly a worse condition than reduced wages.

Unfortunately, workers do not always realize that the only source from which their wages can come is the money received for the things that their labor produces. If the Government sets an arbitrary price for goods, all costs for raw material, labor, transportation, interest, insurance, wear on machinery, depreciation on plant and power must come out of that price, before any profit is left for the employer to compensate him for the risks he runs in doing business.

Items, aside from labor and profits, are largely fixed by causes outside the control of the employer. If labor gets wages so high that the profit left is not enough to warrant the risk of capital in the business, the employer cannot keep on except as a matter of philanthropy. If profits are excessive, or if a reasonable profit does not leave wages sufficient to support the workers, they will, of course, refuse to work.

While the conditions are somewhat different when prices of commodities are set by a competitive market, the results as between wages and profits are about the same. Neither Government nor employer can create money with which to pay wages. It must come from the sale of the product.

Arbitrary fixing of both price and wages by Government results in fixing profit, which may be too large, or may be so small as to prohibit continuance of the business. In the latter case, the employer has no recourse but to stop. In the former, the buyer of the goods is mulcted to increase the profits of the employer. Neither condition is desirable.

We are all vitally interested in accomplishing as soon as possible a readjustment that shall establish industry on a normal basis, giving just returns to employers and employes, doing away with unemployment and ensuring friendly relations between employers and employes, with means for giving employes a knowledge of the business which will enable them to understand the financial problems of the employer, will tend to prevent industrial disputes and will afford a method of adjusting amicably any differences that may arise.

To bring out ideas, the National Industrial Conference Board is offering a prize of $1000 for the best article on any one of eight subjects, the award to be made by a committee consisting of Frederick P. Fish of Boston, Dr. Jacob Gould Schurman of Cornell University, and Henry R. Towne of New York. The contest is open to all persons; papers may be of any length, but must be signed with an assumed name, the real name and address being enclosed in a separate, sealed envelope, which has the assumed name on the outside.

Manuscripts are to be sent to the National Industrial Conference Board, 15 Beacon St., Boston, Mass., and must be mailed on or before July 1, 1919, marked "For Prize Essay Contest."

The subjects are as follows:

1. Practicable plan for representation of workers in determining conditions of work and for prevention of industrial disputes.
2. Major causes of unemployment and how to minimize them.
3. How can efficiency of workers be so increased as to make high wage rates economically practicable?
4. Should Government interfere in determination of wage rates?
5. Should rates of wages be definitely based on the cost of living?
6. How can systems of wage payment be so perfected and supplemented as to be most conducive to individual efficiency and contentment of workers?
7. Comparison of social and economic value of closed and open shop.
8. Should trade unions and employers' associations be made legally responsible?

As these questions are vital to all workers, we shall be glad to receive discussions from readers on any of these topics, with the purpose of aiding, if possible, to solve the problems of industrial readjustment.

Confessions of a Flying Engineer

ANSWERING queries of curiously inclined aviation fans is a pleasant sport of returning flyers.

Were you dizzy the first time you went up? How did it feel? How do you know when the ship is flying level? Have you looped the loop, and what happens when the motor stops, are among the question marks.

On the initial flight of about 30 min. duration, the student is handled with care. He is almost never "stunted"; straight flying and simple turns constitute the work and seldom does he become dizzy. It is extremely important that he be impressed with the simplicity of flight, the natural ease of control and the absolute safety of alert, careful flying.

From the moment that the grinning instructor, after inquiring about the tightness of his belt, opens the throttle, the neophyte is never sure of his emotions, or what move comes next. Wholly new sensations are introduced rapidly, rich in new thrills, which in later flights are seldom experienced. On occasions, his stomach cannot see just where its owner is going and follows along afterward, so it seems. One fellow said he felt tip-top, but was afraid to yawn at any time.

Whether the ship is flying level is indicated by the position of the nose of the ship or engine rocker arms with relation to the horizon. Or, should the horizon be invisible, as it is in passing through mist or clouds, a

racing or decreasing speed of the motor serves to tell of downward or upward flight. Pressure of the rear of the seat against the pilot's back is also an indication of descending or ascending flight and is one of the parts of an experienced pilot's quality known as "feel of the ship." This is a cultivated sense which instinctively tells him the position of the ship without watching the nose and horizon, and whether his control is good. Skillful, correct flying "feels" good. Most cadet flyers who fail to gain pilot's ratings have shown inability to acquire readily the "feel of the ship."

Many laymen are uncertain regarding the consequences, and some still believe that the stopping of an airplane motor in flight results in confusion, or that the ship is apt to come spinning down out of control.

If the pilot finds himself with a suddenly stopped propeller or "dead stick," he will ordinarily first do a nose dive, "jazzing" the throttle meanwhile, to see if the tremendous blast of air on the propeller will start the motor. Frequently the attempt is successful.

If the motor "konks" or cuts out completely and fails to respond to a starting test, the pilot experiences no alarm and little concern. He knows that a forced landing is the next event on the program. With a few cuss words, because the maneuvering or particular air work must be temporarily postponed, he immediately places the nose of the machine the proper distance below the horizon to give the correct normal gliding angle; a distinctively pitched hum of the wires also indicates the correct glide. In a normal glide with power off, the controls are wholly effective, although not quite so sensitive as with power on, and if the pilot has reasonable altitude, he has ample time to look around, select a suitable landing field and maneuver down to it. Skillfully executed forced landings are a source of pride to all pilots.

Most training planes have a gliding angle of 7 to 1, that is, if they have an altitude of one mile, they can safely glide seven miles with power off. Speedier battle planes have less wing area and this ratio is less. Direction and strength of wind also influence the gliding range of a plane.

Twelve Thousand Disabled Ask Retraining

APPROXIMATELY 200,000 disabled men are coming home. Many of these will return to their old vocations, but thousands of them will need re-education before they can become self-supporting citizens. These disabilities range from amputations to that far larger per cent of internal wounds, tuberculosis, shell shock and other contracted diseases. That in each case he may overcome his handicap has been proven by hundreds of those who have already been retrained. Men who have suffered amputation have become successful farmers, bee keepers, tailors, welders and professional men. The deaf have taken agricultural and mechanical training and have made good. The blind (the per cent of the blind is very small) have been taught to work as typists, poultry men, and assemblers in machine shops. Outdoor occupations have opened a path to the tuberculous, and other occupations have been found compatible with other handicaps.

Today over 12,000 men are registered with the Federal Board for Vocational Education of Washington, which is the agent of Congress in this work. A tentative classification of the first 157 cases approved for training indicates the wide diversity of vocations for which they are being trained; 63 distinct courses of training are reported embracing agricultural, commercial, technical and professional choices, with some cases of specialized work in jewelry and architecture; 44 institutions are represented in the schools in which these disabled men have been trained, and over the entire country there has been the most cordial co-operation in the schools in offering their facilities for the use of the Federal Board in this work.

The work has enlarged and grown to such an extent that besides the regular 14 district offices over the country, 6 branch offices have been opened. The board does not stop with the retraining of the disabled men, but has interested itself in getting the employers to give their co-operation. That is the keystone of this carefully considered plan of the government—the hearty, intelligent and untiring co-operation of the employers in giving work to the disabled men, not from charity or patriotic gratitude, but from a just realization that in spite of a handicap a trained worker is of real worth to the business. The re-education of disabled soldiers is free to them, and the federal board is trying to get in touch with all in need of it.

Government Power Investigation

SECRETARY of the Interior, Franklin K. Lane, has asked Congress for an appropriation of $50,000 for an investigation of power resources all over the United States. Another appropriation asked is $200,000 for a report on the power supply in the northeastern part of the country from Boston to Washington. On the face of it, the amounts seem inconsistent, but from the wording of the first request it appears that the $50,000 asked is only a partial amount to be immediately available.

The work is to be carried out by the Geological Survey, with the idea of developing a plan for generating and distributing power which shall utilize undeveloped water power, establish large power plants at tidewater and near coal mines, feed electrical energy into interconnected trunk transmission lines, and supply industrial centers according to their needs.

Arguments in favor of the plan are that it will make for a better load factor on generating stations, will relieve railroads of a great freight burden in haulage of coal, will permit electrical operation of trains where found desirable, will permit development of water powers remote from industrial centers, will increase reliability of service and will make spare units in one plant available for helping out excess requirements at other points.

The plan would seem to have possibilities for economy, and at any rate it is desirable that we have exact knowledge as to what measure of interconnection and centralized supply of power is for the best interests of the country. We can well afford the expenditure of the amounts asked for in order to get a scientific basis for procedure in future power plant development.

Operating Economizers

THE ARTICLES on Economizers, appearing in the Jan. 1 issue, are fine; but I am afraid some of the readers may get the wrong impression and think that economizers are all clear gain. I have an economizer installation that cost upward of $100,000.

The induced draft apparatus is rated at upward of 600 hp.

This apparatus, we will say, is good for 10 yr. of service.

Now, if the energy put into the fans were all lost, i. e., not recovered in the form of exhaust steam, but furnished by electric motors, and it took 2 lb. of coal per kilowatt-hour to operate the motors, which wouldn't be very bad, it would require something like 900 lb. of coal per hour to furnish power to the fans.

The readers do not notice a fan in the drawing on page 21 of the Jan. 1 issue, but in practice the fan is there about 97 times out of 100, I am told.

If the fans were operated 20 hr. a day, this extra coal would amount to 18,000 lb., which would cost us $80 in round numbers, or $24,000 for 300 days.

If the business is paying 10 per cent, then the one hundred thousand would be worth ten thousand, and if deterioration is really 10 per cent, as some people would have us believe, there is still another ten thousand to add. So far we have got about $44,000 charged against the outfit, which means we have got to save some coal to balance accounts.

We figure that we will raise the water about 80 deg. F. or we will say 88 deg. F. to get 8 per cent saving.

Now, if we burn 160 tons of coal a day for 300 days, that will be 48,000 tons a year.

Our saving will not balance our costs in this case.

We have to use all our exhaust steam from the auxiliaries to make a showing and drive our fans by steam instead of electricity.

Also we must put our water in the economizers as cold as we dare, say 90 to 95 deg. F. and use the exhaust (which we formerly put through the heater) to good advantage in the process of manufacture.

Now, if we can get the feed from 90 to 230 deg. F., or say 233 deg. F., we will get a 13 per cent gain, or almost 21 tons of coal saving, which will amount to about $60,000 per year.

I could write a small book on the theory and practice of economizers, which would make the readers laugh and cry in turn, but honestly they are a help and do their bit along with the other accessories; however, don't think that it is possible to install them and then lie back in the harness.

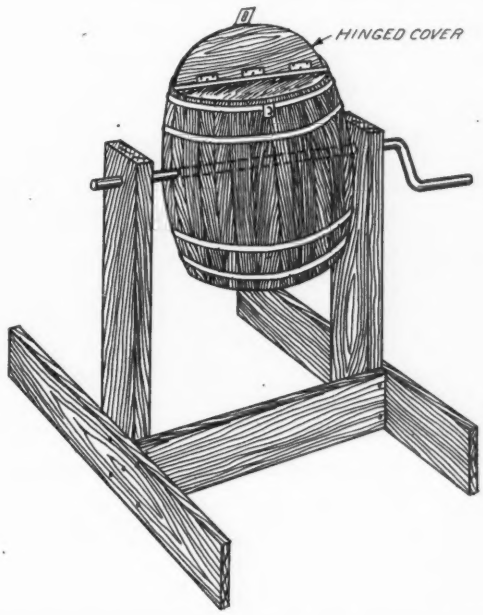
The economizer needs the same watchful attention that the rest of the plant needs and then it will do its part.

TOM THUMB.

Tumbler For Mixing Coal Samples

THE SECURING of a representative sample of coal from a large quantity or shipment for test purposes is not only important but requires great care. If the sample collected is not an average of the lot, the final work of analyzing will not give an indication of the results wished for.

A 1000-lb. sample is usually taken when run-of-mine coal is being tested, and the method of quartering and then discarding the three-quarters until a 5-lb. sample is obtained is generally recommended by various authorities. The labor involved in this method is considerable,



ASSEMBLY OF TUMBLER USEFUL FOR MIXING COAL SAMPLES

and however necessary and important it may be, it is not always carried out in practice. Particularly is this so in the small plant, where the necessity of this care is not so strongly appreciated, and where space and convenience are generally at a premium. If facilities were offered to store the various samples from dofferent parts of the same shipment until it was desired to take an average of the lot, much more reliable results would be obtained.

For instance, if in a small plant it was desired to have the average of the coal supplied, say, 50 tons, and this might be delivered over a period of five or six days, seldom would an average sample be secured. In most cases the last load or the first would be sampled, and that would have to stand for the whole shipment.

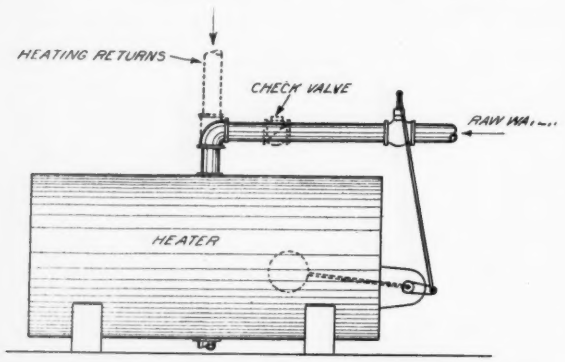
The accompanying sketch illustrates a device that might facilitate the sampling of coal, which might be delivered over long periods, storing the various samples and in the end preparing and securing a fair average of the various samples.

It consists of an oil barrel supported by means of pipe on a stand as illustrated. One end of the pipe is bent to serve as a handle. The top or head is cut in half and hinged. As each load is delivered a small shovelful is thrown into the barrel. When the last shovelful is obtained the cover is closed and the barrel revolved by means of the handle. The interior can be studded with nails or wooden cleats, which in the movement of the barrel will break the large lumps. The 5-lb. sample can then be taken from the barrel and the rest discarded. This method will secure a place of storage for the various samples and a good average of the whole.

J. M. PURCELL.

Return Water Connection to Heater

ON STARTING UP the heating system and providing for the conservation of the returns and condensate from the system, it was found that no opening had been provided on the feed heater for receiving these returns, the only inlet to the heater being for the cold water supply. It was at first thought necessary to cut a hole



HEATER WITH SINGLE WATER SUPPLY CONNECTION

into the heater shell; but after giving the matter some thought, we decided to introduce the return water in the manner shown in the sketch. We removed the elbow on the feed supply line, and in its place used a tee, the upper branch of which received the return water. While the direct down flow of the return water into the heater would doubtless have been sufficient to prevent its backing into the raw water line, we decided to make doubly sure that this would not occur and placed a check valve in the position shown. This arrangement worked out very satisfactorily, the return water forming the bulk of the supply, the raw water being supplemented in only sufficient quantity to make up the deficiency.

M. A. SALLER.

Replacing a Large Valve

AN 8-IN. GATE VALVE in the main steam header needed replacing with a new valve. The chief had put the job off from Sunday to Sunday, as the valve had been in service several years, and he expected a good deal of trouble getting the nuts and bolts loose, and had estimated that it would take three men as many hours to complete the job. With several shops using central station service to full capacity on Sunday, the superintendent would not give his permission for a 3-hr. shutdown.

A boomer repairman had been hired a few weeks before who one day asked the chief for one helper and 2 hr. the following Sunday morning between the hours of 5 and 7 a. m., at which time none of the shops were using current. He guaranteed that the new valve would be in place. "Boomer" pleaded so hard that finally the chief went to the superintendent's office. When he came back, permission was granted to go ahead at the time mentioned.

On Saturday afternoon the "Boomer" put his chain falls, braces and other rigging in place. Imagine the surprise of the day gang when he placed a ladder against the valve and then calmly started to loosen a nut and bolt. As each nut and bolt was taken out, it was liberally treated with graphite and cylinder oil, put in place and tightened up. Each bolt holding the valve was treated in the same way. When it came time to put in the valve the next morning, it required very little time and not much effort to remove the pre-treated nuts and bolts. Service was interrupted just 40 min.

JACK L. BALL.

The Use of Shellac in Electrical Repair Work

SHELLAC VARNISH is extensively used in electrical repair work as an insulating medium, and for the purpose of firmly cementing coils together. While shellac properly used and allowed to dry thoroughly before the apparatus is put into service invariably gives satisfaction, it is not by any means generally known that shellac varnish while wet or even damp is almost as bad as water, regarded as a short-circuiting medium.

Wires differing widely in electrical potential are frequently very close together, if not actually side by side in the stator windings of induction motors of the 600-volt variety, and when the short distance that intervenes between such parallel wires is considered in connection with the cross section of the conducting path from wire to wire, it will be readily understood that a strata of damp varnish of even high resistance under such conditions offers a path to the current that will show high insulation leakage even under a potential of 110 v. The writer constructed a couple of small transformers of 110-12-6 ratios and used shellac liberally in the construction.

It was found that ordinary drying out for three or four days or a week accomplished nothing in the way of securing insulation. The first one was placed on top of the boilers for about three days, after which it was O.K. Previous to this, a lamp would light up between primary and secondary or between either coil and the iron core. The second one was treated the same way before using, and worked all right. The writer has had similar experience in constructing heating devices in which the wire was imbedded in plaster of paris. The same measures had to be employed as to forced drying, ordinary drying not proving satisfactory. Where such insulating mediums are used, i. e., those that have a solvent such as water or alcohol, possessing conducting power, the apparatus should always be tested out with

a 100 or a 600-v. lamp-testing outfit, or with a suitable voltmeter used in the same way. For emergency repair work, where it is necessary to put the apparatus into service at short notice, the correct thing to use is an insulating varnish that is made up with a solvent that is itself an insulator. This does away with waiting for drying, and the result is that the apparatus is ready for service at once. T. H. REARDON.

Using Kerosene in Boilers

I HAVE a 150-hp. horizontal return tubular boiler in which I use kerosene for the removal of scale in the following manner. After the boiler is cut out I empty it of all water, open the manholes and remove all loose sediment, if any is present. I then enter the boiler and apply the kerosene freely with a wide brush, and especially in the heads and stays.

When doing this work, be sure the kerosene soaks through the scale, and if one coat proves insufficient, apply more, or until the scale becomes saturated.

Close the boiler with test cock and steam gage cock open (to relieve possible pressure due to formation of gases) and leave stand for a day or two. Fill with water in the regular manner, fire up slowly until a pressure of from 2 to 3 lb. has been built up, after which allow the fire to die down, blow out the water and open the manholes.

You will then find, upon examination, instead of hard scale, some muddy matter here and there, which may readily be washed out. J. HADINGER.

AFTER having unsuccessfully used various kinds of compounds, a boiler inspector suggested that I try kerosene to remove scale from my boilers, which had given me considerable trouble. He advised putting in the boiler while empty 1 qt. of kerosene, so that, as this worked its way between the scale and the iron, the scale would come off. The first time I opened the manhole after having treated the boiler in this way, I was much surprised to find about ½ bu. of loose scale, while each of the next two times the boiler was shut down for cleaning at least 150 lb. of scale were removed.

I would, therefore, suggest to any one troubled with scale to try kerosene, using 1 qt. for each 100 hp. of boiler capacity.

W. B. C.

IN A PLANT in which I was once employed as assistant engineer, the feed water was taken from an artesian well and like most waters from such a source contained considerable scale-forming ingredients. To remove the scale thus formed, the chief engineer used kerosene, introducing this into the main feed line between the pump and the boilers. With this arrangement it was, however, found that the kerosene had not been properly distributed, so several simple and inexpensive sight-feed lubricators were purchased and one of each fitted to the individual boiler feed lines.

Soon after beginning the use of the kerosene, scale could be heard passing out through the blowoff pipe each time the boilers were blown down and the fireman reported his inability to close the blowoff valves on account of the lodging of scale between disks and seats. This, however, was afterward remedied to a great extent by more frequent washing out.

Other difficulties we experienced, due to the use of the kerosene, was the almost continual destruction of rubber joints and the disagreeable odor emanating from the radiator air valves.

Under no conditions should a boiler in which kerosene has been used be entered for cleaning or inspection until the interior of the shell has been thoroughly dried, this is especially so when an open flame is used for lighting purposes. If this precaution is not taken the kerosene vapor may ignite and not only cause damage but also bodily injury.

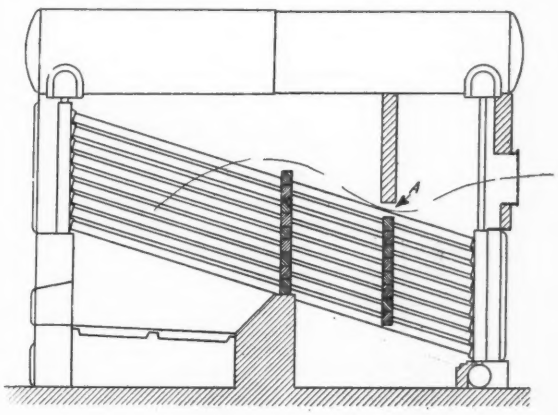
Before entering any such boiler it should be thoroughly dried and it is well as a further precaution to pass a lighted candle into the shell during this by attaching the candle to a stick of sufficient length.

RECEIVER.

Boiler Baffles

THE WRITER had an experience some time ago that was a good object lesson, and showed the importance of keeping a lookout for defective boiler baffles.

Two 300-hp. boilers were being erected, and when No. 1 was finished it was put in service and easily carried the load. When No. 2 was finished I ordered it put in service and No. 1 cut out. In a short time the fireman reported that he could not hold the steam, and as the boilers were exact duplicates I went to the boiler room to investigate and found that the fireman knew what he was talking about, and had the boiler cut out and No. 1 put back in service.



INCORRECTLY BUILT BAFFLES CAUSE REDUCED CAPACITY

On further investigation I found that the top row of baffle brick at A, in the sketch, had been left out by the erecting man, who had depended on his helper to put them in. This allowed the most of the gases to pass directly to the flue, and while this opening was only one brick wide, it apparently reduced the capacity of the boiler about one-third, if not more.

Moral: Inspect your boiler baffles.

R. L. MOSSMAN.

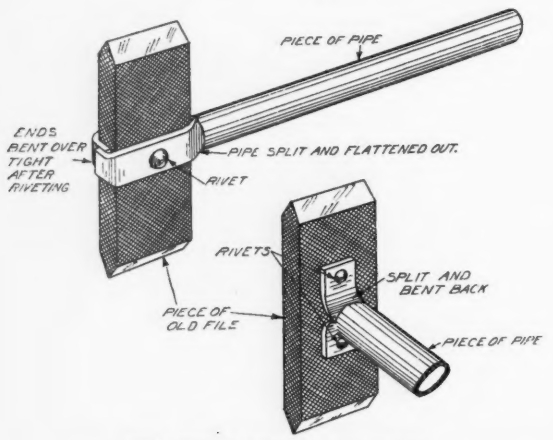
Corrosive Action of Flue Dust

IN GENERAL, the penetration by the dust is greater in fire clay than in silica fire bricks. In most cases the bond is attacked first and the coarser grains last. In silica bricks the depth of penetration by the dust

is generally less the finer the grain. In the fine-grained bricks the coarser grains and the bond are both attacked, while in the coarse-grained bricks the bond alone is attacked to any serious extent. It therefore follows that the bond of a silica fire brick offers the feeblest resistance to the attack of a corrosive slag. The attack on the coarses grains of silica fire brick varies with the nature of these grains. When there is much cementing material between the quartz grains the penetration of the rock fragments by the dust is greater than in the case of a compact rock made up of interlocking grains. Under oxidizing conditions, iron oxide does not corrode silica bricks to any noteworthy extent; but under reducing conditions ferrous silicate forms and acts as a corrosive flux. In trials with bulldog dust the silica bricks were far less attacked than were fire clay bricks, and generally the iron oxides corrode fire clay bricks more than they do silica bricks. The dusts apparently exert an influence on the conversion of the quartz into the low specific gravity form or forms, even where the coarse grains have apparently not been penetrated. This is possibly in part due to the vapors of the alkalies in the dust. There is also some evidence that contact with oxide or iron in oxidizing flame hastens the conversion of the quartz. MARK MEREDITH.

Scaling Tools

HANDY and economical scaling tools can be made from old worn-out files. Two types that the writer has



TWO TYPES OF SCALING TOOLS

used are shown in the sketches. Large size files are the best, for they give weight and width.

The holes in the file are drifted in with blacksmith's drift or punch while the file is at a red heat. The handles are made of ½-in. pipe. This makes a very durable tool. The pipe gives added weight, making the work of the tool excellent. C. H. WILLEY.

Curing Pitted Pump Rods

WE RECENTLY PURCHASED a second-hand pump, and on putting it in service we found that it was impossible to prevent leakage through the stuffing box, because of the pitted condition of the rod, due to the use of inferior oil in the past, or more probably due to improperly adjusted stuffing box or packing. We did not like the idea of putting in a new rod, and after trying several suggested remedies we finally lessened and then overcame the difficulty by treating the rod with a mixture of tallow and white lead, as recommended by a neighboring engineer. This composition was swabbed on the rod three or four times a day, the tallow acting to carry the white lead into the pits and crevices, where it gradually built up and formed a hard surface, soon imparting an even surface to the rod and eventually stopping the leaks. Other engineers suffering from pitted or corroded pump rods might try this suggestion to advantage. M. A. SALLER

Clarifying the Monthly Coal Statement

THE IMPORTANCE of making a clear statement as to the amount of coal on hand at a certain date each month, the amount consumed, cost of that on hand and used, etc., is recognized by innumerable power plants. Nevertheless, there are many other stations which pay little attention to fuel accounting, and which are seldom in a position to answer searching questions about the cost and extent of their monthly supply. For this reason, the following tabulated statement of coal as employed by a large plant in the East may be of interest in view of its clarity.

	Price per ton	No. tons	Cost
Dec. 1, 1918, coal on hand	$ 9.625	46,249	$446,203
Dec. 31, 1918, net coal received (Dec.)		7,125	68,794
		53,374	$513,997
Average price per ton	$ 9.629		
Price adjustment on heat basis	0.654		
Coal delivered to bunkers, Dec. (burned)		10,280	$ 98,994
Carrying Charges:			
Handling, storage, etc. $ 72.90			
Losses 5.65			
	0.764		
Interest 26.83			
Insurance 6.80			
	0.324		
$112.19			11,219
Total coal cost (burned)			$110,214
Cost per ton (burned) in Dec.	10.720		
Price adjustment heat basis	0.654		
	$11.374		
Coal on hand Dec. 1 and received in Dec.		53,374	513,997
Burned in Dec.		10,280	98,994
Bal. coal on hand, Jan. 1, 1919		43,093	$415,002

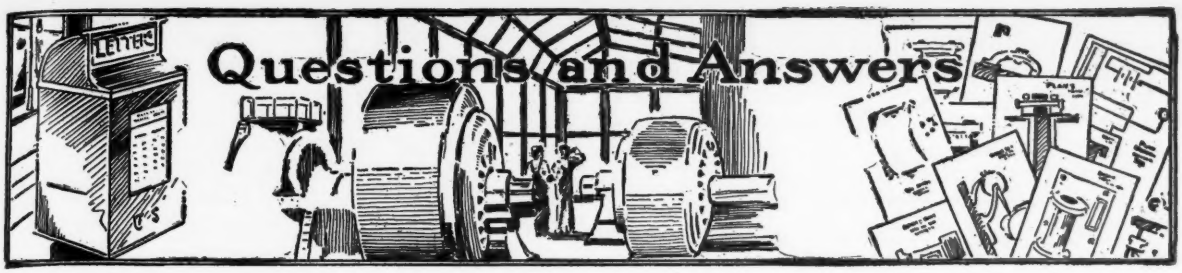
H. S. KNOWLTON.

Don't Try It

WE WANTED a simple method of figuring the safe working pressure on an old boiler mutilated by Germans during their drive into France. So we decided to consult Steve, a stray helper, who invariably had fresh doctrines, a fierce exponent of many new scientific principles not found in ordinary engineering literature.

"It's simple," he said. "Just take S, the ultimate ultimate breaking point of the fireman's suspenders, in pounds per button, multiply by the length of the boiler room in inches, the age of the chief in months and the cost of Limberger cheese in cents per pound. Divide this by D, the diameter of the boiler room clock, in centimeters, and F, a variable factor of safety of three to six miles, reduced to meters."

IN MAKING a coal pile of mixed sizes, the coal should be so handled as to make a homogenous pile and prevent the segregation of coarse and fine coal. This frequently determines the most desirable machinery for unloading coal.



Removing Brine from Ammonia System

LAST SPRING considerable brine found its way into our ammonia system and I wish to inquire whether our ice machine, an 18 by 14-in. single double-acting compressor will handle this or whether I could or should blow it back out through the expansion valve. This valve, which is as high as the tank, is the only outlet I have. A. J. R.

A. The amount of brine in the ammonia system cannot be so very great if the plant has been able to operate during a whole season.

Some of the brine has circulated with the ammonia and has been sent to the trap or gas receiver on the discharge line. This has been drawn off with the oil if the trap has been emptied at regular intervals as it should be.

What brine is still in the system must be got rid of during the overhauling period.

After all the ice in the tank is frozen solid, empty all the cans and fill them with raw water. This filling is done so as to keep the brine level high enough to submerge all the coils. Allow the temperature of the brine to rise to at least 60 deg. F.

Now, with the liquid valve between the liquid receiver and the expansion valves closed, run the machine slowly and pump down the low pressure side of the system until the back pressure gage shows just a trifle below atmospheric pressure. Then stop the machine and close the suction and discharge valves at the compressor. The closing of these valves is a precaution taken to guard against ammonia leaking back into the tank coils through leaking compressor valves.

Watch the back pressure gage and when it shows about 15 lb. pump down again to atmospheric pressure. This starting and stopping may have to be repeated several times, as the high brine temperature will evaporate any ammonia contained in the oil and brine in the coils.

Watch the condenser pressure closely while pumping out, and stay close to the machine in case a slug of brine should be pulled over. This is not likely to happen, but it is best to be careful.

After the ammonia is all out of the tank coils, disconnect the flanges between the expansion valves and the coils. Do this disconnecting carefully by first loosening the bolts and prying the flanges apart. If the ammonia is all out, complete the disconnecting and also disconnect the coils from the suction line.

Next the cans are all emptied and the brine removed from the tank. Save the brine by storing it in the ice cans if no other place is available.

The coils are then disconnected top and bottom and blown out separately with steam and air.

Allow the steam to blow through long enough to heat the coil hot. Follow the steam with dry air at 100 lb. pressure just as soon as the steam is shut off. The steam will remove all oil and brine or other foreign substance and the dry air will remove the moisture left by the steam.

If the coils of this ice tank are connected up so that either inlet or outlet header is at the bottom of the tank look for a plugged opening which should have been provided with a blowoff valve. If no such opening is found, drill and tap the bottom header or manifold and put in a blowoff or drain of ¾-in. size; most tanks have such a drain.

Now the brine has all been removed from the ammonia except a small amount that passed to the condenser with the circulating ammonia. To remove this, it is advisable to install an ammonia purifier and connect it up so that it can be filled from the bottom of the liquid receiver, the bottom of the oil trap on the discharge line and also from the drain of the ice tank coils.

Use the purifier continually until not a trace of foreign matter is noticeable. That will mean simply this: to keep a good clean heat absorbing charge of ammonia in the system, the purifier should be in constant use.

A. G. SOLOMON.

"Boil Over" in Absorption System

IN ABSORPTION refrigeration systems what causes a "boil over" and how may that be prevented?

I have had considerable trouble with this of late and am anxious to know how I may remedy it. W. H.

A. In regard to your trouble with "boil over" in your absorption system, this may be due to any one of several causes. If your rectifier is not getting enough water, it will result in making wet gas, then the tank will act as an absorber, and the generator charge will be weakened so that the liquid will "boil over" faster than the drain pipes can take care of it.

The remedy for this is, cut down the steam on the generator, open the expansion valve to the coils more, blow out the rich liquor in the tanks and get the ammonia back to the generator and absorber. It is a process which will take some time and patience.

It may be that your analyzer, if you have a live steam type, is not working well, and that this is permitting too much moisture to pass on into the rectifier; or it may be that the separator between the rectifier and the condenser is not taking out the moisture properly.

Another trouble may be that the charge in your system is too weak. This will have to be strengthened, of course, by adding more ammonia. Your rich liquor should test up at about 26 deg. Beaume by the hy-

drometer, and your poor liquor, 17 to 18 deg. If the poor liquor is coming back richer than this, and the rich liquor is showing weak, there is probably a leak in the exchanger, which permits the rich liquor to work back into the poor liquor side. If you find this condition, the remedy, of course, will be to take down the exchanger and get the leaks out of it.

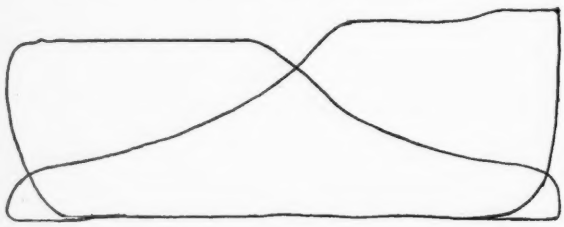
Unequal Cylinder Pressures

THE INDICATOR CARD shown herewith was taken from a 14 by 24 by 30-in. Rice and Sargent engine, the valves and cylinders of which have but recently been rebored and refitted.

I would like to know what may be the cause of the difference in pressure between the two ends. All cards taken indicate the same difference in pressure.

A. F. H.

A. The difference in pressure between the two ends of your cylinder is probably due to the small opening of the steam valve for admission, on the end where the pressure shows low.



RICE & SARGENT ENGINE CARDS INDICATING UNEQUAL CYLINDER PRESSURE

The fact that this throttles down is indicated by the rounding off corner at admission, which shows that the valve does not open wide and quickly. This may probably be due to a twisting of the valve stem, or to a slipping of the valve crank on the stem, or it may be due to a wrong adjustment of the link between the wrist-plate and the valve hook.

Care of Storage Batteries

HOW LONG is a storage battery used for automobile starting, lighting and ignition good? What are the indications when it is becoming weak and will it still be good to be used for ignition purposes only after it gets so it will not start the engine? Is there room enough in the bottom of the cells to take care of sediment during life of the battery or will it have to be cleaned out in the meanwhile?

Some garages advocate the taking down of the battery every fall, drying out the elements and reassembling in spring, using new separators and acid, while others give the battery a freshening charge once a month. Which is the better method? If the first, does not that loosen a lot of the material which otherwise would remain on the plates?

Is it a good idea to pour out the old acid in the spring and put in new and then charge battery? Do you gain anything by so doing? After taking the battery apart why cannot you solder the connections back on instead of having them burned on? If so, what do they use for flux?

L. L. P.

A. The life of a storage battery depends almost entirely on how well it is taken care of, and how much it is used. If it is allowed to stand for long periods partly charged, there will be a tendency to sulphate, particularly if the weather is cold, which will give a tendency, also, to warp the plates. The guarantee on a storage battery is usually for 12 mo. when new, and for 6 mo. when repaired.

The indication that a battery is partly discharged is usually a drag when working the starting mechanism. The way to test it is to use a hydrometer and test the specific gravity. This should be between 1.27 and 1.3, and if it drops below 1.23 the battery should be recharged at once.

Generally what happens when a battery gives way is, that one cell becomes sulphated, or the separators break down and battery is short-circuited. The only remedy for this is to have the offending cell taken out and re-insulated, and if it is sulphated, have the sulphate cleaned off.

For normal sediment, there is space enough in the bottom of the cell to take care of it, but, of course, where there is considerable sulphating, or where a plate warps enough to throw off an unusual amount of the paste material, this space will not be sufficient.

If a battery is to be unused for all winter, probably the best plan is to take it down and lay the plates away dry, reassembling the battery in the spring. This is, of course, more expensive than the method of putting the battery away in a warm place and giving it a freshening charge, and putting in distilled water every month or so, and probably the latter method will bring a battery through in good shape, unless it is partly sulphated to start with.

It is always a good idea to have the old acid taken out of the battery, have it thoroughly washed and filled with new acid at least once a year. My own preference is to do this in the fall, if the battery is to be used in the winter, as the winter service is much harder on it than the summer service.

The objection to soldering the connections on a battery is that you cannot get a joint in this way which will withstand the vibration in an automobile. A soldered joint will stand all right on a small wire where there is some flexibility, but not on the heavy terminals of the storage battery. Also, a soldered joint, unless it is perfect, is likely to have considerable resistance, and this will cut down the power which the battery furnishes to the starting motor.

Reversal of Arc Welder Polarity

WHAT CAUSES the polarity of an a.c. arc welding generator set exciter to reverse while the machine is in operation?

Then what will cause the polarity to reverse again when one of the exciter brushes is raised an instant and then dropped?

Can these changes take place in a d.c. generator?

F. W.

A. This reversal is caused by a discharge from the main field of the welding generator flowing back through the fields or armature of the small exciter. Under cer-

tain conditions, the transformer effect resulting from the operation of the bucking series field which regulates the main generator will induce the current in the separately excited field, wound on the same pole, which will flow back through the exciter. My experience has shown that in some cases this is caused by the current flowing through the exciter armature, producing an armature reaction strong enough to reverse the exciter field polarity. This can be overcome, however, by properly setting the exciter brushes.

Raising one of the exciter brushes also produces the same reversal effect. The effect of raising this brush is to withdraw the exciting voltage from both the exciter field and the main generator field. The main generator field having the larger time constant will therefore discharge back through the exciter field, reversing its polarity. Repeating the operation of raising the exciter brush will cause the polarity to reverse each time.

B. W. David,
The Lincoln Electric Co.

Operating Steam Boilers in Ohio

Is a person required to have a license in order to operate a 35-hp. boiler in the State of Ohio?

2. What does the Ohio law state relative to this matter? C. A. McC.

Answers

Section 1047 of the Ohio License Laws reads as follows: "No person shall operate a stationary steam boiler or engine of more than 30 hp. without obtaining a license to do so, as provided in this chapter. A horsepower as used in this section shall mean 12 sq. ft. of boiler heating surface. No owner or user or agent of an owner or user of any such steam boiler or engine shall permit it to be operated unless it is directly in charge of a duly licensed engineer."

Power Transmission Problems

I am interested in power transmission and am trying to find out whether it is more economical to run my plant with several small steam engines necessitating steam lines 100 ft. long or would be cheaper to have one central engine and a line of shafting 100 ft. long and take the different drives from this main shaft.

If a shaft line would be best, how large a shaft would be necessary to transmit 100 hp.? J. W. M.

A. In order to give you any definite reply it would be necessary for one to make a detailed inspection of your plant and perhaps run a test. On the face of the matter, however, it would appear to us as if it would be more economical for you to operate your plant from one prime mover, either through the medium of line shafting or electric motors, rather than to employ separate steam engines, necessitating the use of excessively long steam lines. The condensation losses, coupled with the low over-all efficiency which would result in such an arrangement, would prove very uneconomical.

In regard to the size of shafting required to transmit 100 hp., we would offer you the following formula:

$d=\sqrt[3]{90 \text{ hp.}+N}$ for turned shafts;

$d=\sqrt[3]{70 \text{ hp.}+N}$ for cold rolled shafts;

where d is the diameter of the shaft, in inches, hp. is the horsepower to be transmitted, and N is the number of revolutions per minute at which the shaft is to turn.

When the shaft is a head shaft carrying the main driving pulley and distributing power to receiving or line shafts and is well supported by bearings, these formulas will be employed:

$d=\sqrt[3]{125 \text{ hp.}+N}$ for turned shafts;

$d=\sqrt[3]{100 \text{ hp.}+N}$ for cold rolled shafts;

for all general purposes, we would suggest that you use this formula:

$d=\sqrt[3]{90 \text{ hp.}+N}$.

Keeping Slack Side of Belt Above

We are planning to install a 120-kw. generator to be driven by our 150-hp. Corliss engine. The only available place for the generator is back of the engine. I have choice of two evils, either to run the engine over, and let the pull come on the top side of the belt, or run the engine under, and let it come on the under side of the belt, where it should come. The manufacturers of the engine say it is far better for it to run over than under. In your opinion, which course is to be preferred? H. B.

A. In stating that your generator is placed back of the engine, we understand that you mean "back of the cylinder." Just why the manufacturers of the engine should recommend running over, we do not, of course, know, although they may have very good reasons for making such recommendation.

Under ordinary conditions, however, we should suggest that you arrange to have the engine run under, for the reason that, with this direction of rotation, the tight side of your belt will be at the bottom, and the slack side on top, and, as a consequence, a high degree of belt contact with both pulley and flywheel is obtainable.

With the arrangement which you mention, that is, the engine running over, the tight side of the belt will be on top and the slack side at the bottom, with the result that the arc of contact between the belt and the pulley, and the belt and the flywheel, will be materially lessened and the efficiency considerably decreased.

Identification of Power House Piping

Please inform me through the columns of Power Plant Engineering what are the standard colors to use on the various pipe lines in a power plant. H. K. S.

A. A scheme for the purpose of ready identification of piping systems is that embodied in the A. S. M. E. report of Committee on Identification of Power House Piping. This committee suggests that colors shall be used on flanges, valves and fittings only, the piping being painted to conform to the color scheme of the room. Its recommendations are as follows:

Steam division—(a) High pressure, white; (b) exhaust system, buff.

Water division—(c) Fresh water, low pressure, blue; (d) fresh water, high pressure boiler feed lines, blue and white; (e) salt water piping, green.

Oil division—(f) Delivery and discharge, brass or bronze yellow.

Pneumatic division—(g) All pipes, gray.

There really is no standard practice relative to color schemes in connection with power house piping systems, but we believe the above will suggest some scheme which you may readily adopt for your particular plant.

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A Working Schedule

The secret of economical operation of power plants is the doing of the right thing at the right time. If an engineer could only anticipate when he is going to have trouble with any piece of apparatus, he would be right there and probably have the conditions changed in time to prevent anything more than a slight inconvenience. Now suppose he experiences that inconvenience about every so often in the regular operation of his plant, it will occur to the wise man not more than twice, for he will then have his time limit set and arrange to care for that particular piece of apparatus in time to avert any trouble in the future.

This is the value of a schedule of operation; it keeps the plant tuned up to proper pitch, everything in working order. Accidents due to neglect do not occur; high efficiency is maintained, nobody is overworked. Everything is lovely. That is, if the schedule is properly made out and diligently followed.

To plan such a schedule and have it lived up to is not so simple as it may seem. Each individual plant has its own peculiarities—water is different; coal is different; load curves are never the same for different plants; hours of work vary; oil and oiling systems are not alike. Each duty of every man needs special study, if best results are to be obtained.

Wide experience and careful reasoning are necessary qualifications of the man who does the planning. Suggestions, however, from outsiders are always of value, and recognizing this fact we are publishing on another page of this issue the last installment in a series of articles by H. A. Wilcox entitled Improving Factory Power Plants, which gives a complete schedule of operation and the method recommended for seeing that it is carried out.

Why the Smoke?

Somewhat more than ten years ago there swept over the country an agitation for laws regulating the smoke nuisance. Many of our cities passed laws making it a crime punishable by a fine for power plants to emit smoke of a definite density for more than a given length of time. Inventors devised appliances for determining the grade of smoke also recording that density. Firemen and engineers were instructed how to operate their furnaces to prevent smoke. Designing engineers worked up furnaces suitable for all kinds and grades of coal. The sun, even, could be seen from the streets of the principal cities.

Perhaps you remember all those historical events, also the great expense attached to the smoke abatement experiments and investigations carried on—they all took place, we assure you.

With such laws on our books and smoke inspection departments maintained at full capacities, with complete knowledge of coals and furnace design sufficient to enable us to burn any grade of coal without dense smoke, and appliances to aid the firemen in preventing smoke, are we, as citizens of such cities, to sit idly by and let our efforts of the past decade go for naught? The war has placed some hardships upon us. It has compelled us to use coal mined in our own district—just what we should have done all these many years—and that required, in some cases, a re-design of furnace

in order to get economical results, this also should have been done long before the zone law went into effect. But we cannot understand by what right a city official can permit plants which are fully equipped with furnaces to burn coal of a quality they have heretofore burned without smoke to belch great clouds of black soot all day long, as is done in one big city of the middle west.

It is time for engineers to assert their rights as citizens, use their knowledge of combustion and compel inefficient smoke inspectors to perform the duties for which they are being paid.

Play, Work or Drudgery

When a man goes through a system of exercises, either physical or mental, with the desirable reward immediately at hand, whatever that reward may be, he is, according to psychologists, at play. Put the reward farther off in the future, thus taking away the immediate incentive for the exercise and requiring self control for the continuance of the performance and we have work. Now take away the hope of reward from the mind of the subject and the exercise he goes through in this condition becomes drudgery.

Do you play, work or drudge; in other words are you master of your mind to such an extent that you can make drudgery to other people work to yourself, or work to other people play to yourself, or even drudgery to others play to yourself?

It is inconceivable that a bunch of twenty odd college boys accustomed to life in refined homes and at the age when personal appearance seems all important to them, would for pleasure roll each other about during a rain storm in an open field covered with mud. Yet most of us have seen this very thing done in foot ball games. Was there a reward? Yes, but it did not come in a material form, it was purely mental. Can we not get something of the same reward in our everyday work? Do we need a grandstand full of merrymaking people to put enthusiasm into our work in order that we may make play of it? Why not just for the contentment it gives, school ourselves to enjoy solitaire? It is just as much fun to beat yourself at a difficult task as to outwit an opponent and a whole lot more profitable in the way of development.

It is when men play with their work that they make the greatest headway; when they can bat it around like the cat does a mouse; when they have that pride which comes with mastership; when they can meet every phase, turn or angle of their work with the confidence of understanding and skill. Many phases of power plant work are drudgery to the man who looks only at the coal bunker or ashpit through the glasses of "five o'clock and pay day." To such a man a little visit with the "coal fairy" will make a world of difference in his attitude towards work. There are many "fairies" with wonderful histories and experiences for all of us to become acquainted with, and intimate companionship is a delight, a pleasure and an immediate reward well worth the effort.

Play, work and drudgery are outwardly the same thing—exercise—inwardly, however, they mark the difference between success, progress and failure, between freedom, self control and slavery.

Government Ownership

WITH the present widespread activity of the Government in industrial affairs, and the threat of further increase if the desires of some officials are followed it behooves us to examine carefully such records as are available of the success or failure of Government ownership in this and other countries.

In Great Britain, government management of railways as a war measure has resulted in a loss of $200,000,000 on 24,000 miles of lines. In this country, in spite of a saving estimated by Mr. McAdoo at 3 to 4 million dollars a year through reforms that were not permitted under private management, the loss, with 25 per cent increase in freight rates and twice that in passenger rates, shows nearly $1,000,000 a day. In Germany, the government railroads, with wages half those on U. S. railroads, show rates 90 per cent above rates in this country.

On telephone lines, France loses $1,800,000 a year, Germany lost, up to 1914, $5,000,000 a year on telephones and $3,500,000 on the telegraph system. New Zealand lost $313,000 in 1913 and Australia nearly $800,000. Great Britain, from 1870 to 1914, showed an average yearly loss on her telegraph system of $4,500,000.

Nowhere is there encouragement to believe that government ownership or operation can give as good service or at as low cost as private enterprise for any form of public utility.

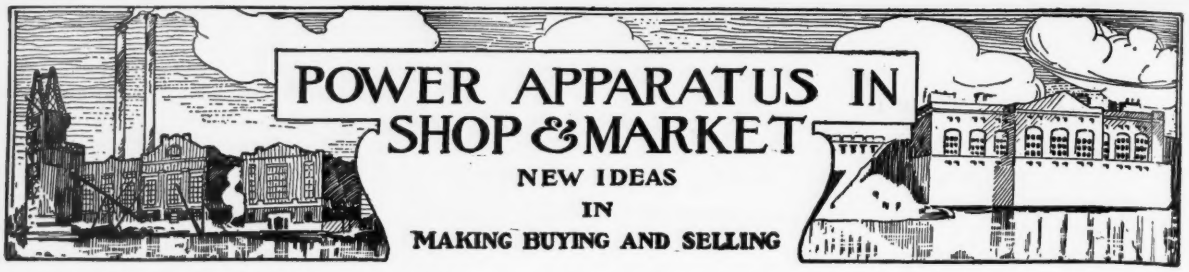
Modern Farms Want Mechanics

GREAT interest is being manifested by modern farmers in obtaining disabled soldiers who have been retrained by the federal board for vocational education as "farm mechanics," the new profession evolved by the board and in which many injured soldiers are now being retrained.

"What work is there on a 200-acre farm for a mechanic?" is a common question put to the federal board. The farmer could afford to have a tractor if he has a man who can keep it tuned up to maximum efficiency. Anybody who can handle a tractor can prescribe for the ordinary ills of a stationary gasoline engine. A farm with a gasoline engine can have water under pressure if there is a man available who can do an intelligent job of pipe fitting. Such a man can make the ordinary repairs and adjustments on an automobile. The installation and care of a low voltage electric light plant including the storage battery is quite within his ability. The upkeep of farm machinery can be attended to between tractor jobs. The life of farm machinery is short because of lack of care in upkeep.

Labor is the big problem on a farm. Mechanical equipment makes the farmer practically independent of transient labor and enables him to do away with part of his equipment of teams. In doing this he not only saves the cost of the team, harness, barn room and work of caring for them, but he saves their food, or in other words, he has more acres for income crops.

This broadening of the disabled man's training and work increases his ability to locate himself advantageously and makes it possible for him to obtain a permanent position rather than a temporary or seasonal job.



Enclosed Tank Switch

THIS switch is of the single-pole double-break type, is instantaneous in action and suitable for use with tanks, etc., wherever regulation of liquid level between high and low limits is required.

This regulation is obtained by a float operating the switch, which in turn actuates a solenoid controlling mechanical or other electrical devices.

The joint of the case is flanged to permit the use of a gasket when desired for waterproofing and the internal electrical and mechanical parts are separated by an inside dividing partition which forms two separate compartments. A block of transite ebony asbestos bolted into the electrical compartment of the case supports the fixed contacts and also acts as an insulating bushing for the incoming wires, which are brought through a threshed boss in the back of the case.

The fixed contacts are short cylinders of carbon held by set screws in machined brass terminals bolted to and insulated by the transite block.

The moving contact is a folded copper strip bolted to a piece of transite, which is loosely pivoted in the forked end of the cam lever. A flat spring within this fork keeps the contact piece always in correct position.

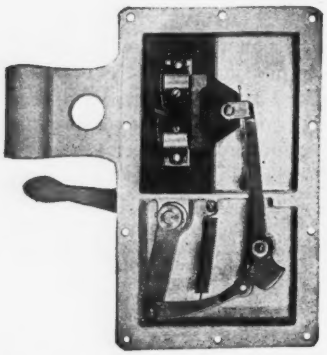


FIG. 1. TANK SWITCH WITH COVER REMOVED

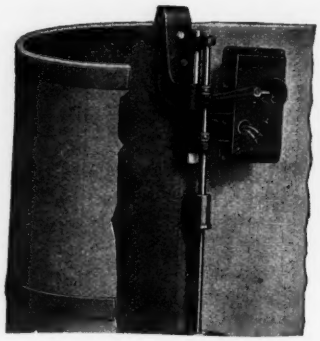


FIG. 2. SWITCH MOUNTING FOR ROOF TANK

The operation, referring to the illustration, is as follows: As the float riding up and down on a guide rod hits a limiting stop on the road, the rod is carried up or down, and through collars upon its upper end imparts a corresponding movement to the switch lever.

Movement of the lever oscillates a shaft and "grasshopper" levers which in turn move a roller across a cam on the end of the electrical contact lever. The roller is held closely to the cam by a coil spring fastened to the dividing partition in the case. The tension from this spring throws the contact lever with a quick positive motion the instant the roller passes over the center of the cam.

This switch is furnished alone or with auxiliaries for mounting either on a cover or a tank wall. It has been approved by the Underwriters Laboratories

Safety First Induction Motor Pedestals

HAPPILY, in manufacturing operations, safety and efficiency are so related that an improvement in either usually effects an improvement in the other. More and better work is produced when light, air, sanitation and disposition of machinery are such that working conditions are pleasant and healthful, and comparative freedom from liability to occupational or accident disability exists.

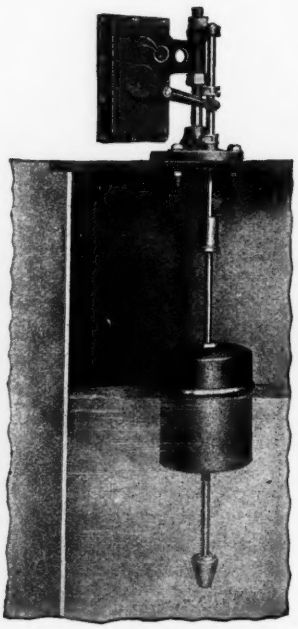


FIG. 3. MOUNTING FOR SUMP

In connection with the requirements of safety, the panel illustrated in Fig. 1 is of considerable interest. It is adapted particularly to the control of alternating-current feeder or motor circuits in capacities up to the rating of 300 amp. and 2500 v.

By referring to Fig. 2, it can be seen that the unit consists of a 300-amp. oil circuit breaker mounted on a pedestal constructed of steel plates and angle iron, the former holding the latter in position and serving as mountings for the apparatus in the interior of the pedestal. The compartment immediately beneath the break-

er and surrounded by the steel plates is used for mounting the potential and current transformers. The space above the switch serves as a housing for the disconnecting switch, and also provides a location for either voltmeter or ammeter or both when desirable. Other instruments such as watthour meters, etc., may be mounted on the sheet-steel front of the panel. The back of the pedestal is also a sheet-steel plate removable to allow access to the interior.

The voltmeter and ammeter are mounted on a cast base above the breaker, and with the front edges of the instruments flush with the casting. Back of the instruments in the interior of the housing are spring contacts which make contact with the instrument studs, so that after removing the holding screws the instruments can be removed from their support without disconnecting the leads. When the instruments are replaced, the connections to them are made automatically. The instrument resistances are mounted behind the instruments.

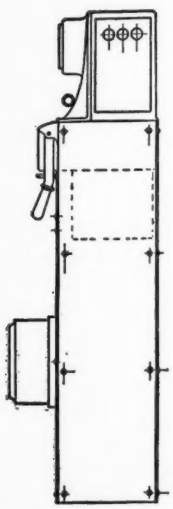


FIG. 1. 2300-V. INDUCTION MOTOR PEDESTAL
FIG. 2. PEDESTAL TYPE SWITCHING UNIT

The watthour meter is mounted on the lower front of the pedestal. The studs run through insulating bushings to the interior where they are connected to the leads from the current and potential transformers which are mounted on strap iron supports connecting the angle iron uprights. The drilling of the supports permits mounting either one or two current and potential transformers without additional drilling.

The oil circuit breaker is operated in the usual manner by an iron handle from the front. Automatic protection is obtained by two series overload coils provided with dashpot time-limit trip. The under voltage release weight hangs in the small space shown. The oil circuit breaker can be operated only when the disconnecting switch is closed.

The disconnecting switch is operated from the front of the pedestal by a removable handle so interlocked with the oil circuit breaker that the disconnecting switch can be operated only when the breaker is open.

The breaker can thus be cut out of service at any time when open, and can be inspected or repaired without danger. The oil tank cannot be taken off the breaker nor can the cover over the disconnecting switch be removed unless the disconnecting switch is open.

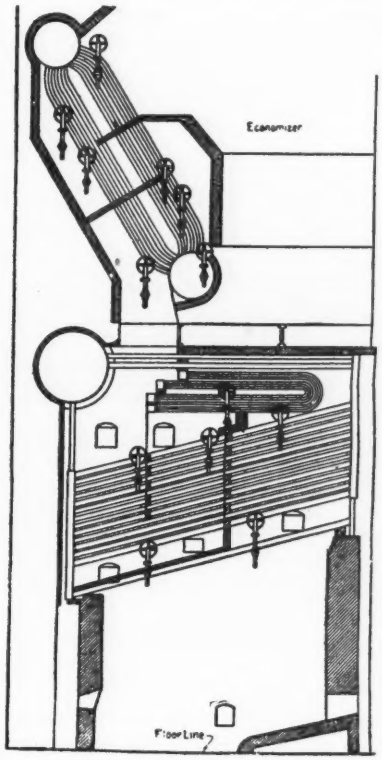
The disconnecting switch and the oil circuit breaker can both be locked open by removing the disconnecting switch handle. This handle can be removed or attached only when the disconnecting switch is open.

It is impossible to get at the live parts of any of the apparatus until portions of either the back or the front of the pedestal have been removed.

The panels occupy small space and are easy to install. Pedestal type units are designed for single or group mounting and have a large bus compartment just above the disconnecting switch and inside the cast iron housing. Connections run either to top or bottom of the pedestal, but as a rule the leads enter from the bottom as this is generally the more convenient arrangement. After being put in place the pedestals are secured by bolting to the floor.

Unique Boiler and Soot Blower Installation

THERE ARE at present 6 1300-hp. boilers with 13,512 sq. ft. heating surfaces in the Kansas City Light & Power Co.'s Northeast station. The working pressure is intended to be 300 lb. and the evaporation per boiler between 70,000 and 120,000 lb. per



BOILER AND SOOT BLOWER INSTALLATION AT PLANT OF KANSAS CITY LIGHT & POWER CO.

hr., with feed water temperature at 220 deg. F. Each boiler is served by a stoker and has an economizer with heating surface of 4000 sq. ft.

The economizers are built of standard parts of boilers to save time in delivery, reduce cost and at the same

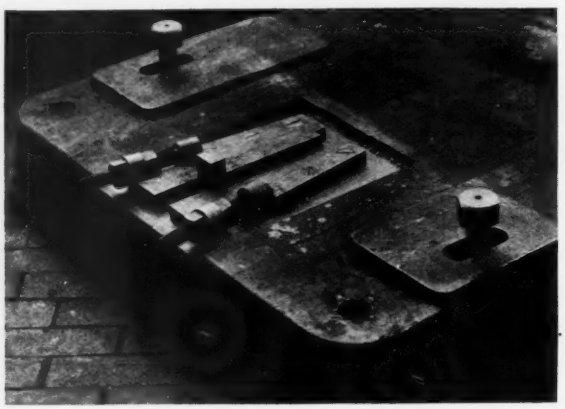
time satisfy the requirements imposed by the operating pressure.

Soot blowers are used for removing soot on both boiler and economizer heating surfaces. The use of soot scrapers for the economizers with tubes of the shape used would be a difficult proposition. Each boiler has six soot blower units on each side with twenty-one nozzles each, the economizer six units of nineteen nozzles on each side, and the superheater two units. Two units are installed for each pass of the boiler. The first set of nozzles are seen to be located directly above the front wall, where they are able to keep the first rows of tubes free of clinker and flue-gas dust, at once corrosive and otherwise objectionable because interfering with heat transfer obstructing the gas passages, etc.

Six minutes' actual blowing time is required to blow the soot of each boiler, and the steam consumption is about 2600 lb. of steam. The time and steam consumption for cleaning the economizer is the same.

Adjustable Anchorage for Motors

THIS device will support and aline motors from 50 hp. up, and particularly those equipped with magnetic clutches which require a very fine and accurate alinement. By its use it is possible to move the motor to a limited extent in all directions, so that the



APPLICATION OF ADJUSTABLE ANCHORAGE FOR MOTORS

motor shaft may be accurately alined with the machine to be driven, and so insure proper operation.

Where magnetic clutches are used, it is sometimes necessary to move the motor forward, due to the wearing of the clutch surfaces, which can be done in a short time.

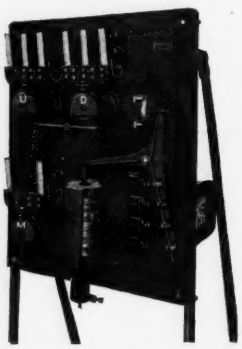
It is almost impossible to get perfect alinement when setting up a motor and it is usually necessary to allow clearance in bolt holes for final adjustment. It is also necessary to depend upon bolts and dowel pins for permanency of the setting. On motors equipped with this anchorage, installations can be made without resorting to extreme closeness, and the final permanent alinement can be obtained in a simple and easy manner.

In case the journal wears unevenly, the motor can be *rotated* and easily brought up into position again, whereas, without the adjustable anchorage it is required that the grooves in the base of the motor be planed out to allow this movement.

Car Switch Elevator Control

SINGLE SPEED passenger and freight elevator service requiring car speeds up to 150 ft. per min. can be successfully handled by a new type elevator control, which is used with compound-wound direct-current elevator motors.

The control is quiet in operation and the car on which it is used is always under complete direction of operator. Some of the features of this control panel are, (1) the directional contactors mechanically interlocked, (2) line contactor, (3) accelerating contactor, (4) contacts interchangeable, (5) accelerating contactor is electrically interlocked with directional contactors (preventing damage to motor from reversing without starting resistance



NEW TYPE ELEVATOR CONTROL PANEL

in circuit), (6) flexible shunt relieves all bearings from carrying current, (7) dependable time element dashpot ratio between resistance steps cannot be tampered with, (8) adjustment for time of acceleration easily made, (9) resistor mounted on panel, (10) all apparatus mounted on pipe framework.

Acceleration is smooth and uniform, being effected automatically and thus entirely independent of the operator; it is impossible to injure the electrical apparatus by careless or ignorant manipulation of a car switch.

The control is designed with time limit acceleration, with capacity for handling 10-hp., 115-v., or 20-hp., 230-550-v. direct-current motors.

The apparatus is simple, consisting of a control panel, a car switch and such elevator safety devices as may be required.

A black marine finished slate panel is furnished with a pipe frame for floor mounting, and carries a main-line contactor, two directional contactors, which are mechanically interlocked, and an accelerating contactor, controlled by a large air dashpot for cutting out the starting resistance and series field. The resistors are mounted on the rear of the panel, making the control apparatus a complete unit which can be mounted in any convenient place near the elevator motor, and rendering all parts easily accessible for inspection at any time.

Provision is made on the directional and line contactors for a shunt brake circuit, which, when the control circuit is completed, energizes the brake magnet and releases the brake.

The contacts are graphite to graphite of the butt type (no sliding contacts used), and are easily renewed. All contacts, with the exception of those for the inter-

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

POWER PLANT ENGINEERING

STEAM CONSUMPTION OF SINGLE STAGE AIR COMPRESSORS, LB. PER 100 CU. FT. FREE AIR

I.Hp. per hour	Lb. Steam Consumption per	Air Pressure Gage										
		20	30	40	50	60	70	80	90	100	110	120
12		1.36	1.94	2.26	2.62	2.92	3.22	3.50	3.72	3.96	4.18	4.38
14		1.58	2.14	2.64	3.06	3.41	3.76	4.08	4.34	4.61	4.87	5.11
16		1.82	2.45	3.02	3.50	3.90	4.30	4.67	4.96	5.29	5.58	5.85
17		1.92	2.60	3.20	3.71	4.14	4.56	4.96	5.20	5.61	5.92	6.20
18		2.04	2.76	3.39	3.93	4.38	4.83	5.25	5.58	5.95	6.26	6.57
19		2.15	2.92	3.58	4.16	4.64	5.11	5.55	5.90	6.28	6.63	6.95
20		2.26	3.06	3.77	4.36	4.86	5.36	5.84	6.20	6.60	6.96	7.30
21		2.38	3.22	3.96	4.59	5.11	5.64	6.12	6.50	6.93	7.31	7.67
22		2.49	3.37	4.15	4.80	5.36	5.90	6.42	6.82	7.25	7.66	8.04
23		2.60	3.52	4.34	5.02	5.60	6.16	6.70	7.14	7.59	8.00	8.40
24		2.72	3.68	4.52	5.25	5.85	6.45	7.00	7.45	7.92	8.36	8.76
25		2.83	3.82	4.70	5.45	6.08	6.70	7.29	7.75	8.25	8.70	9.11
26		2.94	3.98	4.90	5.68	6.32	6.97	7.59	8.05	8.58	9.05	9.50
27		3.06	4.14	5.08	5.90	6.56	7.25	7.86	8.36	8.90	9.40	9.85
28		3.17	4.29	5.26	6.10	6.80	7.50	8.15	8.66	9.22	9.75	10.20
29		3.28	4.44	5.46	6.32	7.05	7.77	8.44	8.98	9.57	10.10	10.58
30		3.40	4.60	5.65	6.55	7.30	8.05	8.75	9.30	9.90	10.46	10.96
31		3.50	4.75	5.85	6.76	7.55	8.32	9.05	9.60	10.20	10.76	11.30
32		3.61	4.90	6.03	7.00	7.80	8.60	9.34	9.94	10.56	11.15	11.66
33		3.74	5.06	6.22	7.20	8.03	8.83	9.62	10.21	10.90	11.50	12.05
34		3.85	5.20	6.40	7.42	8.27	9.12	9.92	10.54	11.20	11.84	12.40
35		3.97	5.36	6.60	7.65	8.52	9.40	10.20	10.85	11.55	12.20	12.76
36		4.08	5.50	6.78	7.86	8.76	9.66	10.50	11.15	11.86	12.52	13.13
37		4.18	5.66	6.96	8.05	8.99	9.91	10.76	11.41	12.16	12.84	13.45
38		4.30	5.81	7.14	8.27	9.22	10.16	11.05	11.74	12.50	13.20	13.82
39		4.42	5.97	7.35	8.51	9.50	10.45	11.36	12.09	12.86	13.55	14.21
40		4.54	6.12	7.50	8.71	9.71	10.70	11.61	12.35	13.15	13.90	14.56

—O. S. Shantz, in Compressed Air Data.

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POWER PLANT ENGINEERING

TROUBLE CHART FOR GASOLINE ENGINES

LOSS OF POWER

Ignition: Spark occurring too late; spark weak because of partial short circuit or battery becoming exhausted; dirty spark plugs; poor connections; dirty timer; poor or broken wiring in case of magneto; breaker points worn, oily, or out of adjustment: commutator brush dirty or oily.

Fuel: Mixture too lean or too rich; supply pipe partly clogged; inlet valve not opening sufficiently due to wear; water in gasoline; leaks around intake manifold.

Motor: Overheating in cylinder or bearings; gummy, inferior or insufficient oil; exhaust pipe partially clogged; governor out of adjustment; lack of compression, which may be due to worn, stuck, or broken piston rings; scored cylinder walls; leaks through and around head joints; valves sticking, worn, pitted, or not seating properly because of dirt; in cold weather engine and cooling water too cold.

MISFIRING

Ignition: Weak batteries; poor connections; dirty timer; vibrator points pitted or dirty; dirty or cracked plugs, points of plug not properly spaced; make and break points not touching properly.

Fuel: Mixture too lean or too rich; gasoline passage partly clogged; water in gasoline.

Motor: Lack of compression; valves sticky or not working properly.

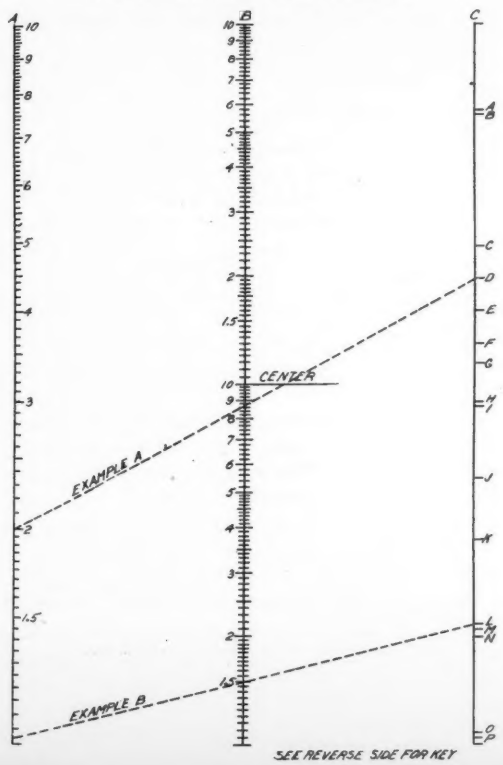
POUNDING

Ignition: Spark too early.

Motor: Red-hot carbon deposit in cylinder; loose bearings; tight piston, due to lack of oil or lack of cooling water; hot bearings; loose flywheel; very loose piston (piston slap).

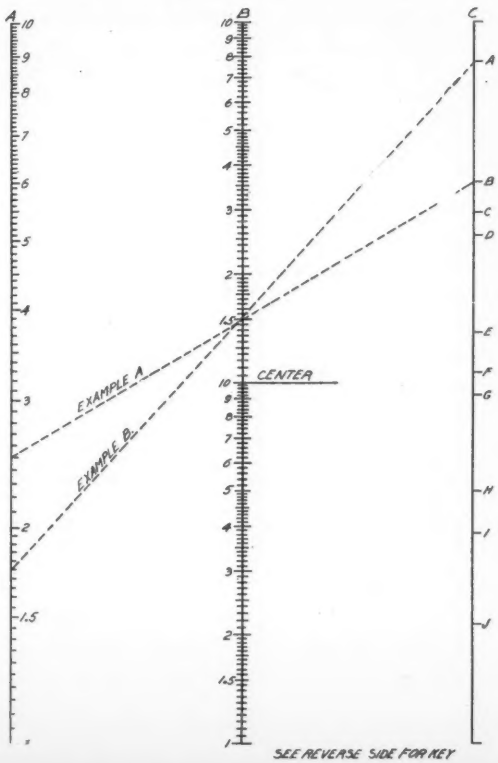
POWER PLANT ENGINEERING

CONVERSION CHART FOR PRESSURE



POWER PLANT ENGINEERING

CONVERSION CHART FOR VELOCITIES



TROUBLE CHART FOR GASOLINE ENGINES

BACKFIRING

Ignition: Spark too late. (If motor backfires and stops, spark may be too far advanced); short circuit on primary wire; wires to wrong plugs.

Fuel: Weak mixture; occasionally too rich mixture.

Motor: Leaky or stuck intake valve; red-hot carbon deposits; leaky manifold or carburetor gasket.

EXPLOSIONS IN EXHAUST PIPE*

Ignition: Irregular ignition; poor spark, or very late spark.

Fuel: Mixture too lean or too rich.

OVERHEATING

Ignition: Spark too late, or very weak.

Fuel: Mixture too rich.

Motor: Insufficient lubrication; insufficient cooling water; circulation of cooling water impeded; pump not working properly; heavy carbon deposits in cylinder; water chamber coated from impure water.

IRREGULAR SPEED

Ignition: Loose connections, or partly broken wire; vibrator points rough, pitted, or improperly adjusted.

Fuel: Supply to carburetor irregular; dirt on needle valve.

Motor: Governor gummy, sticky, out of adjustment or badly worn; valves sticky.

SMOKE

Black smoke in exhaust indicates too rich a mixture. Bluish smoke indicates too much lubricating oil. Smoke from the crank case or open end of cylinder indicates leak past the piston; look for worn rings, rings stuck in grooves, or scoring on cylinder walls.—Farmers' Bulletin 1013.

*Often occurs just after starting due to first charges not firing in cylinder and passing through into exhaust pipe, where burning gases from first few explosions will ignite them.

STEAM CONSUMPTION OF TWO STAGE AIR COMPRESSORS, LB. PER 100 CU. FT. FREE AIR

Lb. Steam Consumption per I.Hp. per hour	Air Pressure Gage 70	80	90	100	110	120	130	140	150
12	2.82	3.01	3.19	3.37	3.54	3.69	3.85	3.96	4.10
14	3.25	3.51	3.72	3.93	4.14	4.30	4.46	4.62	4.76
16	3.76	4.03	4.26	4.50	4.74	4.93	5.11	5.29	5.46
17	3.78	4.26	4.52	4.77	5.02	5.22	5.42	5.60	5.80
18	4.23	4.52	4.79	5.05	5.32	5.54	5.76	5.94	5.14
19	4.46	4.78	5.06	5.34	5.65	5.86	6.08	6.28	6.49
20	4.69	5.02	5.32	5.61	5.91	6.15	6.38	6.60	6.81
21	4.93	5.27	5.68	5.90	6.21	6.46	6.70	6.93	7.16
22	5.16	5.53	5.86	6.19	6.51	6.78	7.03	7.26	7.50
23	5.39	5.77	6.10	6.45	6.80	7.08	7.34	7.59	7.84
24	5.63	6.03	6.38	6.74	7.10	7.38	7.66	7.92	8.17
25	5.85	6.27	6.66	7.01	7.40	7.69	7.97	8.25	8.51
26	6.10	6.53	6.91	7.30	7.70	8.00	8.30	8.60	8.86
27	6.33	6.78	7.17	7.57	7.96	8.31	9.61	8.90	9.20
28	6.56	7.03	7.44	7.85	8.27	8.61	8.98	9.23	9.55
29	6.80	7.27	7.70	8.15	8.58	8.92	9.25	9.56	9.90
30	7.04	7.53	7.98	8.42	8.86	9.24	9.57	9.90	10.20
31	7.26	7.78	8.24	8.70	9.16	9.53	9.90	10.20	10.55
32	7.50	8.03	8.50	8.99	9.46	9.85	10.20	10.56	10.90
33	7.74	8.29	8.77	9.26	9.75	10.15	10.52	10.90	11.25
34	7.96	8.53	9.03	9.55	10.05	10.46	10.84	11.21	11.60
35	8.20	8.78	9.31	9.85	10.35	10.75	11.15	11.55	11.91
36	8.45	9.05	9.57	10.10	10.64	11.05	11.48	11.88	12.26
37	8.65	9.25	9.81	10.35	10.90	11.35	11.76	12.18	12.58
38	8.90	9.53	10.05	10.63	11.20	11.66	12.10	12.50	12.90
39	9.15	9.80	10.35	10.95	11.61	12.00	12.42	12.85	13.28
40	9.35	10.01	10.60	11.20	11.80	12.27	12.72	13.15	13.60

KEY TO CONVERSION CHART FOR VELOCITIES

Scale A	Scale B	Scale C	To locate Decimal* Below Center	To locate Decimal* Above Center
Meters per Sec.	Meters per Min.	B	+1	+2
" " "	Feet per Sec.	F	0	+1
" " "	Feet per Min.	I	+2	+3
" " "	Miles per Hr.	H	0	+1
Meters per Min.	Feet per Min.	F	0	+1
" " "	Miles per Hr.	E	−2	−1
" " "	Feet per Sec.	C	−2	−1
Feet per Sec.	Centimeter per Sec.	G	+1	+2
Feet per Min.	" " "	D	−1	0
Miles per Hr.	Feet per Min.	A	+1	+2
" " "	Feet per Sec.	J	0	+1

*The number of digits to the left of the decimal point in scale B is more or less than that in scale A by the amount shown in these two columns. The scales are read similarly to those on a slide rule, i.e., the numbered divisions represent the first significant figure, the intermediate unnumbered divisions represent the second figure, and the third figure must be interpolated.

Examples: (A) 25 meters per second expressed in meters per minute is 1500. (B) 154 ft. per minute expressed in miles per hour is 1.75.

KEY TO CONVERSION CHART FOR PRESSURES

Scale A	Scale B	Scale C	To locate Decimal* Below Center	To locate Decimal* Above Center
Megadynes per Sq. Cm.	Lb. per sq. in.	M	+1	+2
" " " "	Inches Mercury at 0° C.	I	+1	+2
" " " "	Meters " " " "	B	−1	0
" " " "	Meters Water at 15° C.	P	+1	+2
" " " "	Feet " " " "	J	+1	+2
" " " "	Inches " " " "	E	+2	+3
Atmospheres	Lb. per sq. in.	L	+1	+2
Meters Mercury at 0° C.	" " " "	K	+1	+2
Inches " " " "	" " " "	C	−1	0
Meters Water at 15° C.	" " " "	N	0	+1
Feet " " " "	" " " "	D	−1	0
Inches " " " "	" " " "	F	−2	−1
Atmospheres	Inches Mercury at 0° C.	H	+1	+2
"	Meters " " " "	A	−1	0
"	Feet Water at 15° C	G	+2	+3
"	Meters " " " "	O	+1	+2

* The number of digits to the left of the decimal point in scale B is more or less than that in scale A by the amount shown in these two columns. The scales are read similarly to those on a slide rule, i.e., the numbered divisions represent the first significant figure, the intermediate unnumbered divisions represent the second figure, and the third figure must be interpolated.

Examples: (A) Water under a head of 20 ft. is equal to 8.66 lb. per sq. in. (B) 150 lb. per sq. in. is equal to 10.2 atmospheres.

lock, are interchangeable for alternating-current and direct-current type E controllers, for both car switch and push button operation.

A one-point car switch mounted in the elevator car furnishes the means by which the operator controls the movement of the car.

Safety devices may be connected in the control circuit so that the opening of any switch will bring the car to rest. Those most commonly used are the emergency switches, to be used by the operator in case of accident or failure of the car switch; machine-limit and hatchway-limit switches, which operate automatically to prevent accidents from over-travel, should the operator for any reason fail to release the car switch, and door switches, which prevent the starting of the car until the door is properly closed.

News Notes

SCHAEFFER & BUDENBERG has established a new sales office at Tulsa, Okla., with T. C. Eales in charge as local manager.

DEARBORN CHEMICAL CO. has just opened an office in Kansas City, Mo., at 206 Commerce Trust Bldg., on Walnut St., between 9th and 10th. G. M. Massen and W. H. Fairlamb, the company's representatives in the territory adjacent to Kansas City, will both make their headquarters at this office.

THE CHICAGO PNEUMATIC TOOL CO. announces the removal of its Cleveland District Office from Room 813 to Rooms 406-408 Engineers' Building, effective March 1. The new headquarters will provide excellent facilities for giving the best possible service to the company's expanding interests within the Cleveland District. Ross Watson, district manager, will welcome visitors to the new offices.

THE PULVERIZED FUEL EQUIPMENT CORP. has recently been organized to take over the business of the Locomotive Pulverized Fuel Co. and extend its activities to cover power stations, metallurgical and industrial plants. Officers of the new company are: J. S. Coffin, chairman; J. E. Muhlfeld, president; H. F. Ball, vice-president and executive; H. D. Savage, vice-president in charge of sales; V. Z. Caracristi, vice-president in charge of engineering; S. G. Allen, secretary-treasurer.

THE UNITED STATES Shipping Board wants 1500 husky young Americans at once to learn the business of firing boilers on the new ships of the Merchant Marine, Chairman Edward N. Hurley of the Board announced recently, and will have places for 1500 a month in this rating until further notice.

The men accepted will be placed on training ships at $30 a month training pay for 30 days and will then be sent on deepwater voyages at $75 a month. Uniform and board are furnished. Voyages will be varied, to allow the recruits to see as much of the world as possible and the possibilities of promotion will be emphasized.

Discharged soldiers and naval reservists are eligible for this work. Other young men of good physique and habits, weighing 140 lb. or more, will also be accepted.

Applicants may apply to any of the boards' 3000 drug-store enrolling stations, to the Merchant Marine training stations at Boston, Norfolk, New Orleans, San Francisco or Seattle, or may write or wire Henry Howard, director of recruiting for the Merchant Marine Custom House, Boston.

IN THE Michigan legislature a bill is now being considered which provides for registration of Engineers and Architects on the following basis: Anyone now engaged in such work is not restricted from continuing so long as he does not use the title "Registered Architect or Engineer," except that he may not be employed on public work. He may voluntarily apply for registration and if approved may then use the title "Registered Architect" or "Registered Engineer."

For those who engage in work subsequent to Sept. 1, 1919, examination must be taken before a board of three, one Architect and two Engineers, who are appointed by the governor and must have 10 yr. experience. Examiners are to serve without pay, but are allowed traveling expense.

The fee for examination is $10 and for yearly renewal of registration $2.

The bill is not a compulsory license law, but provides for establishment of a list of engineers whose qualifications are certified by the examiners and who are given the right to use the title "Registered Engineer."

U. S. CIVIL SERVICE COMMISSION announces an examination for assistant superintendent, to fill a vacancy in the State, War and Navy Buildings, Washington, D. C., at $2000 a year, and future vacancies requiring similar qualifications, at this or higher or lower salaries. Competitors will be rated on education, preliminary training and responsible experience. Applicants must show that they have graduated from a 4 yr. high-school course, or completed a course of study equivalent to that required for such graduation, and that for at least 5 yr. they have been employed in positions in which the principal duties involved mechanical or electrical engineering work. The successful completion of each year at a technical college or university of recognized standing will be accepted as the equivalent of 6 mo. of the required experience. They must have reached their twenty-fifth birthday on the date of the examination. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE COMMISSION announces an examination, April 1, for aeronautical engineering draftsman, to fill a vacancy in the position of technical assistant to the National Advisory Committee for Aeronautics, at $1500 a year, and future vacancies requiring similar qualifications, at this or higher or lower entrance salaries. Competitors will be rated on physical ability, education, training and experience. Prerequisites for consideration are: Graduation in engineering from a college or university of recognized standing or 4 yr. of engineering experience, and in addition, at least one year's experience in the design and construction of various types of airplanes. Each of the 4 yr. of engineering experience will be accepted in lieu of each year lacking of the college course. Apply for Form 1312.

ALEXANDER ZELENKO, 167 Post St., San Francisco, Calif., is at present acting as the representative for the

U. S. A. of The All-Russian Central Union of Co-operative Societies. This comprises 500 Provincial Unions and some 30,000 Co-operative Societies.

The purpose of the present representation is to establish direct contact with manufacturers of high-grade standard products, so as to procure machinery and supplies quickly, advantageously and in large quantities. Mr. Zelenko will be glad to receive catalogs in duplicate, and prices for export trade.

Book Reviews

CURRENT FOR THAWING FROZEN WATER PIPES; from a paper by F. J. Gifford before the New England Water Works Convention, the following data as to voltage and current are taken:

Current is usually obtained by tapping the 2200-v. service mains and connecting on a transformer of 15 to 75 kw. capacity, reducing to 110 v. In some instances, where a motor truck is used, the engine of the truck is arranged to drive a 25-v., 250-amp. d.c. generator on the truck to furnish current, and in other cases a storage battery of cells, arranged so that voltages of 8 to 42 could be obtained, was utilized.

For thawing ⅝-in. lead or ¾-in. iron pipes, 4/0 wire was used for leads and a drop of 14 to 18 v. was allowed in the pipe. The total voltage was 20 to 30, the balance being taken by a water rheostat; 175 to 225 amp. were used for 6 min. more or less to clean the pipe. Larger pipes take more energy or a longer time.

The motor-generator set was favored by the committee as a source of current, the motor being adapted for connection to service lines, and the generator with capacity of 25 v. and 250 amp.

APPLIED MECHANICS. Vol. II, Strength of Material. By Charles E. Fuller and William A. Johnson; 9 by 12 in., 538 pp., illustrated; New York, 1919; cloth, $3.75.

Prepared for the use of students in Mass. Inst. of Technology, this book is based on ability to use differential and Integral Calculus and a knowledge of Statics, Dynamics, Center of Gravity, Moments of Inertia of Plane Figures and Solids such as would be obtained from Vol. I.

Equations and formulas are derived by the methods of calculus, but graphical methods are shown where they are adapted for the getting of practical results.

Subjects covered are: Properties of Materials; Stress and Strains; Beams, stresses and deflections; Columns; Shafting and Springs; Curved Bars; Arches and Catenaries; Cylinders and Plates; Reinforced Concrete Beams and Columns.

The treatment in each case is full and clear, and numerous problems are given to be solved, making the use of the various equations evident.

The book is intended for men well versed in mathematics and for such men will be found helpful and satisfactory. The chapter on Reinforced Beams and Columns is rather brief, but covers the most common conditions for such work.

THE FUSIBILITY of Coal Ash and the Determination of the Softening Temperature is the title of Bulletin 129, just issued by the Bureau of Mines, Department of the Interior.

In describing the purposes and scope of the investigations, the authors, A. C. Fieldner, Albert E. Hall and A. L. Field, say:

"As a safeguard against excessive clinker troubles, specifications for the purchase of coal can be drawn to include the 'softening' or 'fusing' temperature of the ash. The value of such information has been recognized by the Bureau of Mines and has induced the bureau to investigate laboratory methods of determining the fusibility of coal ash, and the bearing of the results on clinker formation in fuel beds. The bureau realized that the fusibility of a mixture of oxides and silicates such as is comprised in coal ash varies according to the conditions under which tests are made, and that in the absence of any generally accepted method, no agreement is to be expected among tests made in different laboratories. Indeed, L. S. Marks has recently called attention to differences as great as 390 deg. C. that were obtained with the same sample of ash by two different laboratories. Therefore if a fusion-temperature clause is to have any place in specifications for coal, a standard method of testing should be adopted in order to insure comparable results by different laboratories and to obtain the softening or fusing temperature of the ash under conditions similar to those of a fuel bed. After a consistent method has been devised for obtaining comparable results at different laboratories, there will remain the correlation of these results with those from the burning of coal in furnaces before the value of fusibility tests in coal specifications can finally be determined.

"The present publication reviews the literature on the subject and gives in detail the effect of various oxidizing, reducing and neutral atmospheres such as are found in various parts of the fuel bed on the softening temperature of ash when molded in the form of Seger cones. As a result of this study a practical method of determining fusibility has been developed whereby the ash is caused to soften and form slags in which the iron exists in approximately the same state of oxidation as the iron in fuel-bed clinkers.

"Although it is believed that this method will indicate the probable clinkering characteristics of a coal better than any fusion tests heretofore described, the bureau does not recommend the general use of this method in coal specifications until it is justified by actual trial in furnace tests of different coals. As no fusibility test of a well-mixed sample of the average ash of a coal takes into account the physical distribution of the impurities in the coal as burned, much additional investigation is needed to establish the exact relation of these laboratory fusibility tests to clinker formation. In order to correlate this proposed test of minimum softening temperature with clinker formation, the bureau is now making clinkering tests in a specially designed experimental furnace, in which different coals having ashes that differ in fusibility are burned under similar and known conditions of combustion. The results of this investigation will be published in a subsequent report. In the meantime, it is hoped that other investigators will obtain similar correlation data."

Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.